



**INTERNATIONAL
MULTIDISCIPLINARY ECOLOGY AND
ENVIRONMENTAL STUDIES CONGRESS**

AUGUST 29-30, 2024 / LONDON

**EDITOR
DR. UZMA NADEEM**

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ECOLOGY AND ENVIRONMENTAL
STUDIES CONGRESS**

August 29-30, 2024 - LONDON, UK

EDITOR

Dr. Uzma Nadeem

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CONGRESS ID

CONGRESS TITLE

**INTERNATIONAL MULTIDISCIPLINARY ECOLOGY AND
ENVIRONMENTAL STUDIES CONGRESS**

DATE AND PLACE

August 29-30, 2024 – LONDON, UK

ORGANIZATION

IKSAD INSTITUTE

EDITOR

Dr. Uzma Nadeem

PARTICIPANTS COUNTRY (16 countries)

**TÜRKİYE, ROMANIA, AZERBAIJAN, RUSSIA, ALGERIA, SERBIA, MOROCCO,
INDONESIA, ALBANIA, SAUDI ARABIA, JORDAN, VIETNAM, ITALY, INDIA,
EGYPT, SWEDEN**

Total Accepted Article: 50

Total Rejected Papers: 21

Accepted Article (Türkiye): 18

Accepted Article (Other Countries): 32

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LONDON

INTERNATIONAL MULTIDISCIPLINARY ECOLOGY
AND ENVIRONMENTAL STUDIES CONGRESS

18.09.2024

REF: Akademik Teşvik

İlgili makama;

Uluslararası Multidisipliner Ekoloji ve Çevre Çalışmaları Kongresi, 29-30 Ağustos 2024 tarihleri arasında Londra İngiltere’de 16 farklı ülkenin (Türkiye 18 bildiri- Diğer ülkeler 32 bildiri) akademisyen/araştırmacılarının katılımıyla gerçekleşmiştir

Kongre 16 Ocak 2020 Akademik Teşvik Ödeneği Yönetmeliğine getirilen “Tebliğlerin sunulduğu yurt içinde veya yurt dışındaki etkinliğin uluslararası olarak nitelendirilebilmesi için Türkiye dışında en az beş farklı ülkeden sözlü tebliğ sunan konuşmacının katılım sağlaması ve tebliğlerin yarımından fazlasının Türkiye dışından katılımcılar tarafından sunulması esastır.” değişikliğine uygun düzenlenmiştir.

Bilgilerinize arz edilir,

Saygılarımla

Uzma Nadeem

Assist. Prof. Dr. Uzma Nadeem
ORGANIZING BOARD MEMBER



"16" July 2024

Etibar Gahramanov, from the Environmental Engineering Branch of the Industrial Engineering Department in the Faculty of Architecture and Construction, has been appointed as the academician representative to the Organization Committee of the Environment and Ecology Congress in London on August 29-30, 2024.

Assoc.prof. Afar ALIFOV

Dean of Faculty of Architecture and Construction

Baku Engineering University

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Sevilla University SPAIN

Adam BROIT
LEI (London Ecology Institute)

Girão Fernández
Sevilla University SPAIN

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Baku Engineering University

Assist. Prof. Dr. Uzma Nadeem
Department of Environmental Studies, Mata Sundri College
for Women, University of Delhi, India

Lect. PhD Irina-Ana DROBOT
Technical University of Civil Engineering Bucharest
ROMANIA

Prof. Mohammed Dalli
Higher Institute of Nursing Professions and Health Techniques

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Technical University of Civil Engineering Bucharest ROMANIA

BENFRID Abdelmoutalib

LSMAGCTP UDL SBA ALGERIA

Prof. Mohammed Dalli

Higher Institute of Nursing Professions and Health Techniques

Marianys Girão Fernández

Sevilla University SPAIN

PHOTO GALLERY

observer hall 2

H2 - Eda SELÇUK H2 - Furkan Ozan Çoban H2 - Erhan ONAT H-2 Göktağ Şenürk H-2 Ayşe Ayta Kaşıkçı

Materials & Methods

Bougainvillea glabra
(bracts were air-dried)

grinding

Ultrasound-assisted extraction

Bougainvillea glabra
(bracts were air-dried)

observer hall 2

H2 - Eda SELÇUK H2 - Erhan ONAT H2 - S1 - İrem GAZİZOĞLU H-2 Göktağ Şenürk H2-ASLI MUTLUC

Amphibian Importance

Food Chain Management: As tadpoles, frogs act as natural algae consumers, effectively regulating algal blooms and maintaining water quality. Adult frogs transition to become efficient predators, consuming vast quantities of insects like mosquitoes, thereby controlling populations and reducing the spread of insect-borne diseases. Additionally, they themselves serve as a vital food source for various predators, including birds, fish, and reptiles, ensuring a balanced food web.

Medical Discoveries: Amphibian research has yielded significant advancements in human healthcare. Studies utilizing frogs have directly contributed to roughly 10% of Nobel Prizes in Physiology or Medicine. Frog skin secretions harbour a diverse range of bioactive compounds with immense potential for pharmaceutical development.




PHOTO GALLERY

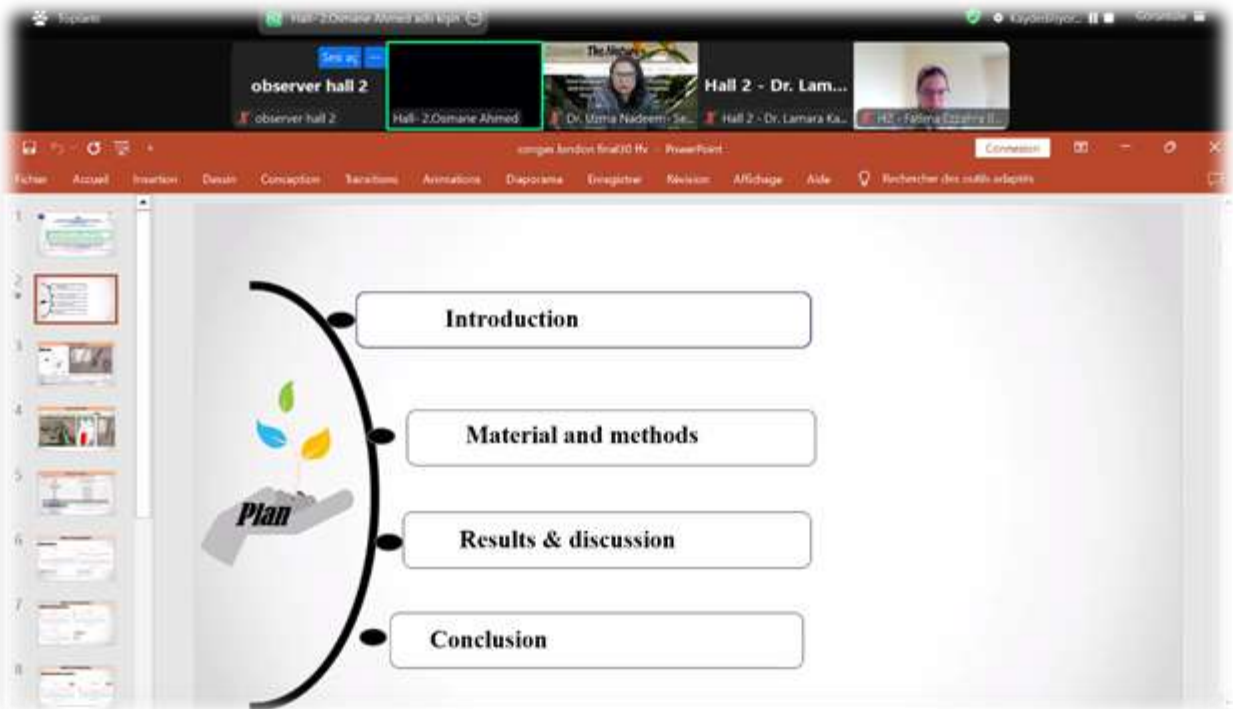


PHOTO GALLERY

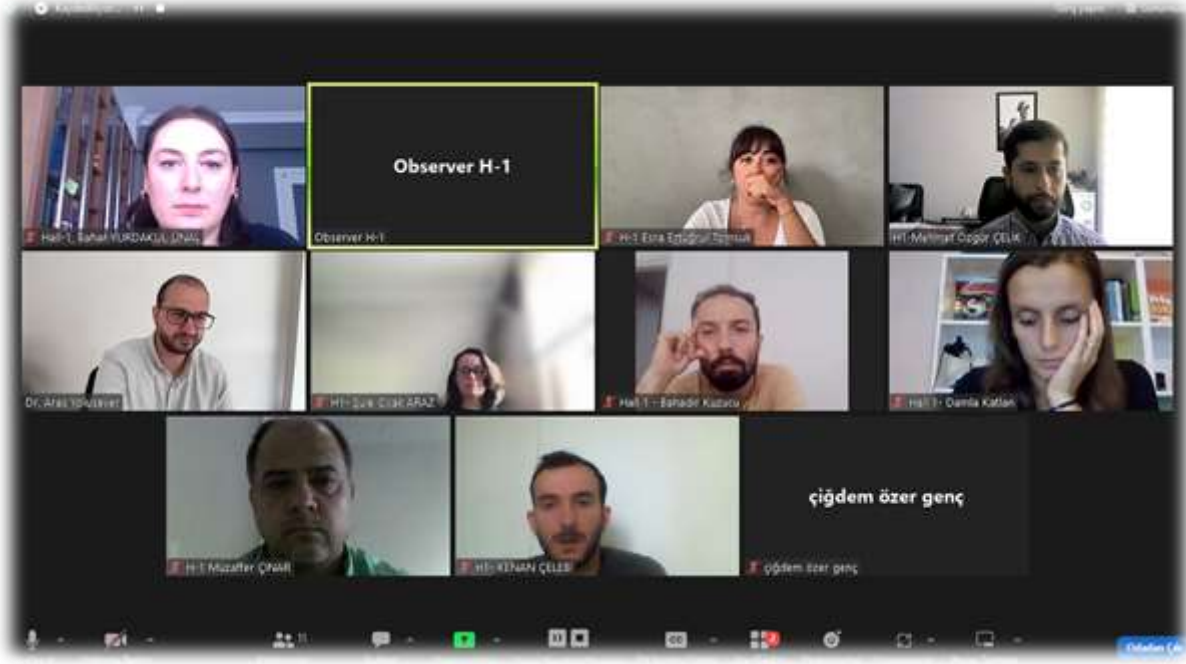


PHOTO GALLERY


Carbon nanohorns- introduction

- In the last years, carbon nanohorns (carbon nanostructures consisting of sp^2 hybridized carbon atoms that form a conical molecular of 2–5 nm in diameter and 30–50 nm in length) have gained increased attention for several applications thanks to their outstanding characteristics such as clean synthesis methods, large specific surface area, availability of high-purity samples, thermal stability, good electrical conductivity, low toxicity, high porosity.
- Thus, both pristine and functionalized carbon nanohorns and their nanocomposites/nanohybrids were used in various fields such as energy conversion, applied electrochemistry, gas sensing, gas storage, and biomedicine;
- Our paper outlines the recent progress regarding the utilization of carbon nanohorns for environmental remediation purposes;
- CNHs can effectively remove pollutants, such as heavy metals, volatile organic compounds and polycyclic aromatic hydrocarbons, from water and air.


Observer H-1
Observer H-1
Hall-3, Vlad Diaconescu
H1,5,2Prof wah...
H1,5,2Prof wahel-Jordan

ver Hall... Hall-3 moder... H-3 Absane...


Influence of ecology on human health




Air Pollution




Water Pollution




Soil Pollution




Light Pollution



Noise Pollution



Thermal Pollution



Radioactive Pollution

PHOTO GALLERY

Observer Hall... H3 S2 dr Ivan Pavlovic Zaara Nabil

H3 S2 dr Ivan Pavlovic.ppt (Compatibility Mode) - Microsoft PowerPoint

- During 2008-2009, first in the municipality of Stari Grad and then in other central city municipalities, the system of baskets with PVC bags for the disposal of dog feces came into being, so that from 2011, eco zones or dog parks were formed in some parks.
- In this paper, we present the contamination of park areas that are included in the eco center program during 2011, the period when programs for the ownership of dog excrement removal through the dog-pot system (baskets for disposing of

Zaara Nabil Kigisinden Herkese
Please sir I can present my work in f...

Observer Hall... H3 S2 dr Ivan... Hall-3, Meriem Ferrah

Pre

Introduction

1. Bibliographic overview on organophosphorus chemistry.
2. Synthesis of α -aminophosphonates using new acid-type catalyst exploring the design of experiment.

Conclusion

PHOTO GALLERY

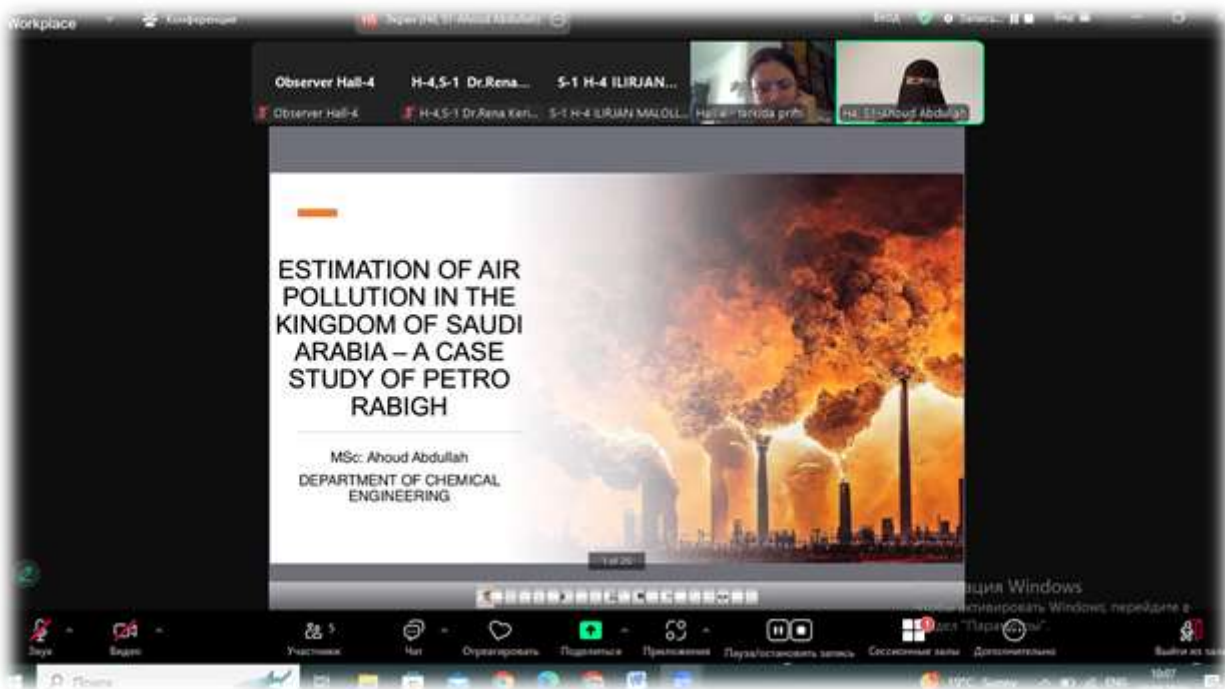
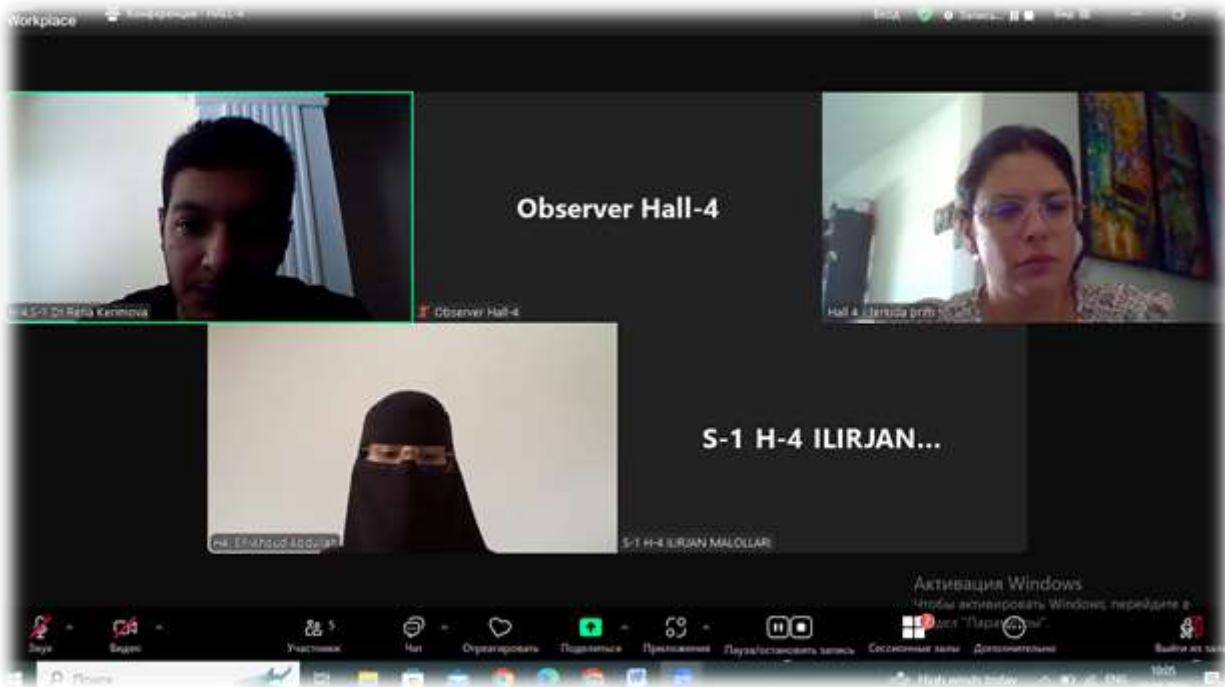
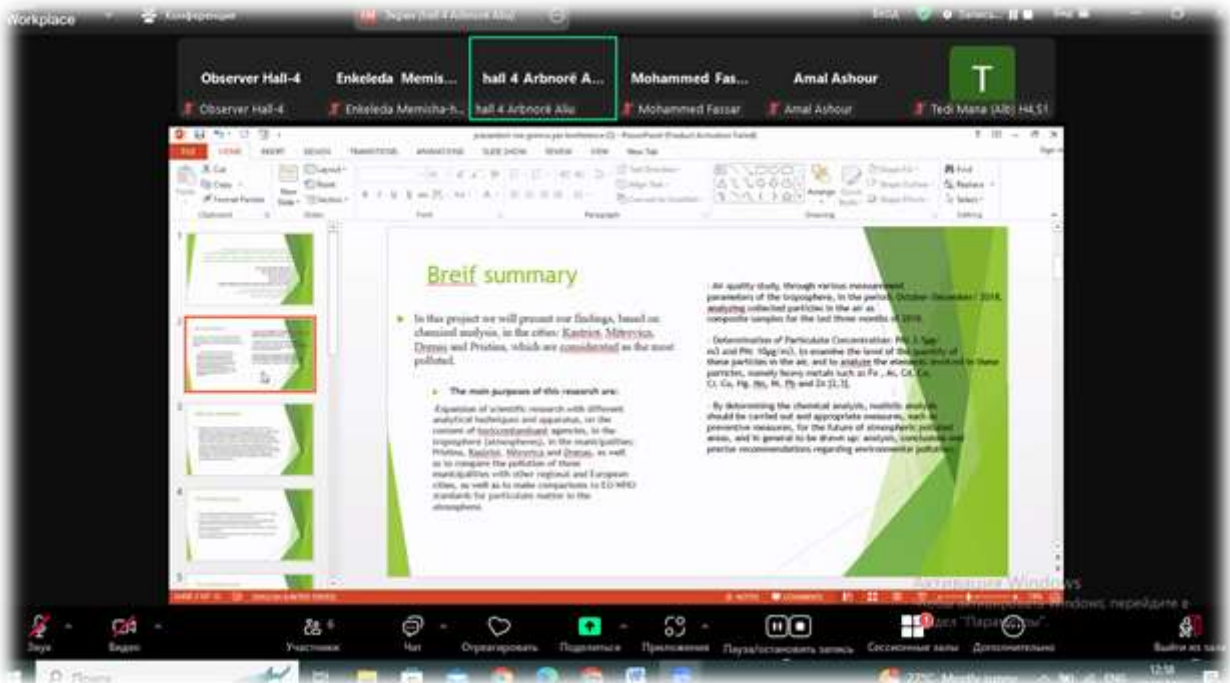
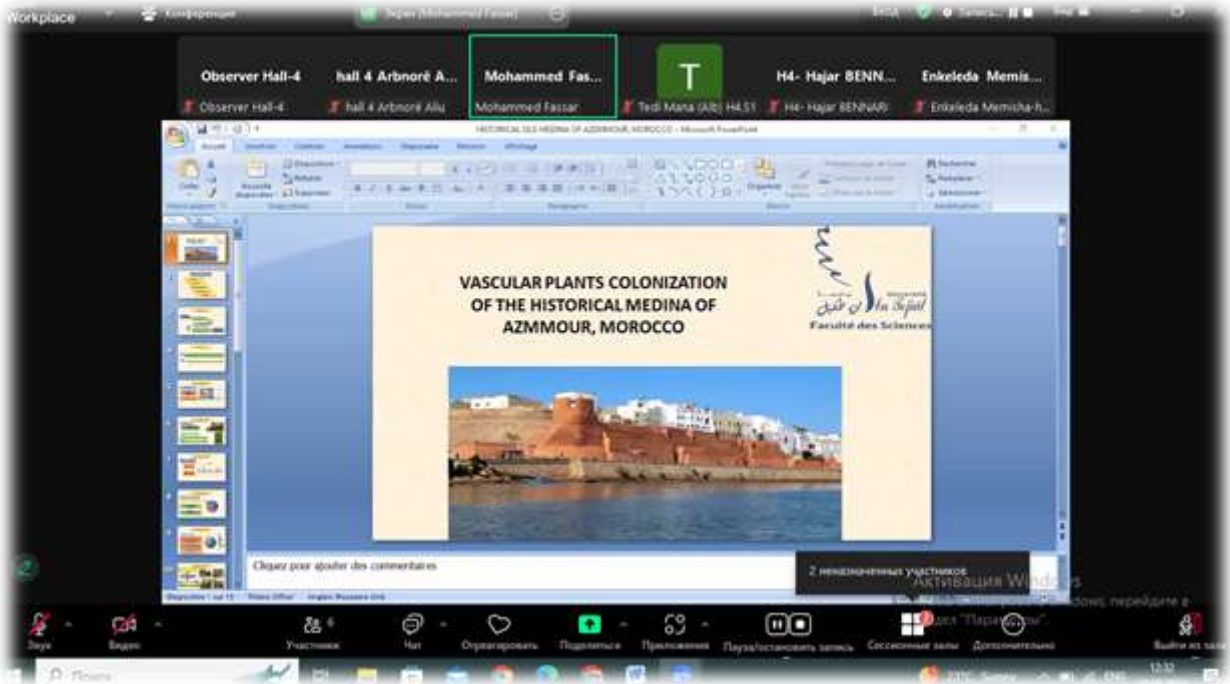


PHOTO GALLERY





INTERNATIONAL MULTIDISCIPLINARY ECOLOGY AND ENVIRONMENTAL STUDIES CONGRESS

August 29-30, 2024 - LONDON

CONGRESS PROGRAM

Participant Countries (16): TÜRKİYE, ROMANIA, AZERBAIJAN, RUSSIA, ALGERIA, SERBIA, MOROCCO, INDONESIA, ALBANIA, SAUDI ARABIA, JORDAN, VIETNAM, ITALY, INDIA, EGYPT, SWEDEN

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- ✓ All congress participants can connect live and listen to all sessions.
- ✓ Moderator is responsible for the presentation and scientific discussion (question-answer) section of the session.

Points to Take into Consideration - TECHNICAL INFORMATION

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Before you login to Zoom please indicate your name_surname and HALL number,
exp. Hall-1, Merve KIDIRYUZ

30.08.2024 | HALL-1 | SESSION-1**London Local Time: 08⁰⁰-10⁰⁰****Ankara Local Time: 10⁰⁰-12⁰⁰****ZOOM ID: 925 4259 6036 / PASSCODE: 303030****Moderator: Observer**

Title	Author(s)	Affiliation
SUSTAINABLE GROWTH: RECENT IMPROVEMENTS	Aras YOLUSEVER	Istanbul Kültür University TÜRKİYE
HEALING AND RESTORING THE SELF THROUGH NATURE: ECOCRITICAL TENETS IN THE MOVIE WILD	Lect. Damla KATLAN	Trabzon University TÜRKİYE
INVESTIGATION OF GLOBAL CLIMATE CHANGE EFFECTS AT MERSIN (TURKEY) SCALE	Mehmet Özgür ÇELİK Assoc. Prof. Dr. Osman ORHAN Assoc. Prof. Dr. Mehmet Ali KURT	Mersin University TÜRKİYE
“THE TRAIN IS THE WORLD. WE THE HUMANITY.”: AN ECOCRITICAL ANALYSIS OF THE SCIENCE FICTION MOVIE SNOWPIERCER BY BONG JOON-HO	Lect. Bahar YURDAKUL ÜNAL	Erciyes University TÜRKİYE
THE ROLE OF ART AS A SOLUTION PARTNER IN THE FIGHT AGAINST CLIMATE CHANGE	Assoc. Prof. Dr. Esra ERTUĞRUL TOMSUK	Çankırı Karatekin University TÜRKİYE
POTENTIAL "SOLUTION IMPACT" OF GREEN ERGONOMICS ON SUSTAINABLE ENVIRONMENTAL PROBLEMS THAT THREATEN HUMAN LIFE	Muzaffer ÇINAR	Ministry of National Education/Izmir Provincial Directorate of National Education/Occupational Health and Safety Unit TÜRKİYE
EVALUATION OF FOREST ROAD NETWORKS WITHIN KASTAMONU REGIONAL FOREST DIRECTORATE	Kenan ÇELEBİ Assist. Prof. Dr. Çiğdem ÖZER GENÇ	Kastamonu University TÜRKİYE
ZIRCONIA PARTICLE-ENHANCED CERAMIC: IMPROVED PHOTODEGRADABILITY BEHAVIOR TO ORGANIC CONTAMINANTS	Şule OCAK ARAZ Ashhan ŞENEL SOLMAZ	Kırıkkale University TÜRKİYE Dokuz Eylül University TÜRKİYE
ANALYSIS OF STARCH LEVEL IN ASPEN TREE POPULUS TREMULA LEAVES TO UNDERSTAND STORAGE MECHANISM IN WOODY PLANTS	Bahadır KUZUCU Prof. Dr. Totte NITTYLA Prof. Dr. Buket KOSOVA Junko TAKAHASHI Sonja VILJAMAA	Ege University TÜRKİYE Faculty of Forest Biotechnology, Umea SWEDEN Ege University TÜRKİYE Faculty of Forest Biotechnology, Umea SWEDEN Faculty of Forest Biotechnology, Umea SWEDEN

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30.08.2024 | HALL-2 | SESSION-1**London Local Time: 08⁰⁰-10⁰⁰****Ankara Local Time: 10⁰⁰-12⁰⁰****ZOOM ID: 925 4259 6036 / PASSCODE: 303030****Moderator: Assist. Prof. Dr. Erhan ONAT**

Title	Author(s)	Affiliation
COMPARISON OF BIOLOGICAL ACTIVITIES OF ETHANOL AND AQUEOUS EXTRACTS OF BRACTS OF BOUGAINVILLEA GLABRA	Res. Assist. Furkan Ozan ÇÖVEN Res. Assist. Ayşegül İNAM Assist. Prof. Dr. Tülay ÖNCÜ ÖNER	Manisa Celal Bayar University TÜRKİYE
FOOD-ENERGY-WATER NEXUS BASED ANALYSIS OF THE AGRICULTURAL CROP PATTERN OPTIMIZATION	Lect. Volkan HACISÜLEYMAN Prof. Dr. Mehmet ÖZGER	İstanbul Technical University TÜRKİYE
METABOLOMIC MODELLING AND NEUROPROTECTIVE EFFECTS OF CARVACROL AGAINST ACRYLAMIDE TOXICITY İIN RAT'S BRAIN AND SCIATIC NERVE	Assist. Prof. Dr. Durmuş HATİPOĞLU Res. Assist. Göktuğ ŞENTÜRK Assoc. Prof. Dr. Mehmet Burak ATEŞ Ayşegül BULUT	Selçuk University TÜRKİYE Aksaray University TÜRKİYE Selçuk University TÜRKİYE Selçuk University TÜRKİYE
INVESTIGATION OF THE IMPACT OF HIGHWAYS ON WILDLIFE IN THE KARABÜK PROVINCE	Assist. Prof. Dr. Mehmet ÇOLAK Ayşe Aysu KABASAKALOĞLU	Karabük University TÜRKİYE
DIGITAL TRANSFORMATION AND CIRCULAR ECONOMY: NEW APPROACHES IN THE CONSTRUCTION INDUSTRY	Assist. Prof. Dr. Eda SELÇUK	Haliç University TÜRKİYE
USE OF SMALL ZEBRAFISH IN OBESITY DISEASE MODEL	Ash MUTLUÇ Dr. Çetin YAĞCILAR Assist. Prof. Dr. Muazzez GÜRGAN ESER	Tekirdağ Namık Kemal University TÜRKİYE
DETERMINATION OF THE ECOLOGICAL VARIABLES AFFECTING THE FUTURE GEOGRAPHICAL DISTRIBUTION OF ANATOLIAN WATER FROG LINEAGE CILICIAN (GENUS PELOPHYLAX) IN TÜRKİYE	İrem GAZEZOĞLU Dr. Banu KAYA Assist. Prof. Dr. Çiğdem AKIN PEKŞEN	Başkent University TÜRKİYE
DEVELOPMENT OF SUPPORTED CATALYST FOR HYDROGEN FUEL TECHNOLOGY FROM TEA PULP	Assist. Prof. Dr. Erhan ONAT	Bitlis Eren University TÜRKİYE

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30.08.2024 | HALL-3 | SESSION-1



London Local Time: 08⁰⁰-10⁰⁰



Ankara Local Time: 10⁰⁰-12⁰⁰



ZOOM ID: 925 4259 6036 / PASSCODE: 303030

Moderator: Lect. Dr. Irina-Ana DROBOT

Title	Author(s)	Affiliation
JAPANESE CULTURAL PRODUCTS BASED ON THE RELATIONSHIP WITH NATURE TO PROMOTE ENVIRONMENTAL CARE AND AWARENESS	Lect. Dr. Irina-Ana DROBOT	Technical University of Civil Engineering Bucharest ROMANIA
THE ROLE OF SAPONINS IN THE RESTORATION OF PHOTOSYNTHETIC REACTIONS OF THE THYLAKOID MEMBRANES DAMAGED BY THERMAL STRESS	Sevil DADASHOVA Rena GANIYEVA Gulnar SULTANOVA Gulnara BABAYEVA Nilufar HUSEYNOVA	Institute of Botany, Ministry of Science and Education of the Republic of Azerbaijan, AZERBAIJAN
INFLUENCE OF ECOLOGY ON EDUCATION AND HEALTH OF STUDENTS	Safarova NISA	Moscow State Medical University RUSSIA
TRANSPORT OF ELECTRONS AND IONS IN THE GAS	Željka Nikitović	Institute of Physics University of Belgrade SERBIA
ENERGY MANAGEMENT STRATEGY FOR A HYBRID RENEWABLE ENERGY SYSTEM COMPRISING PV, WIND TURBINE, BESS, ELECTROLYZER, AND FUEL CELL: A CASE STUDY IN ESSAOUIRA, MOROCCO	Abssane Sara Outzourhit Abdelkader Amatoul Fatima-Zahra	Cadi Ayyad University MOROCCO
ABOUT THE NECESSITY OF MORE SERIOUS ANTHROPOGENIC IMPACT ASSESSMENTS	Assoc. Prof. M. As. Michailov	SWU "Neofit Rilski" – BULGARIA

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30.08.2024 | HALL-4 | SESSION-1



London Local Time: 08⁰⁰-10⁰⁰



Ankara Local Time: 10⁰⁰-12⁰⁰



ZOOM ID: 925 4259 6036 / PASSCODE: 303030

Moderator: Obi, Maryjane A.

Title	Author(s)	Affiliation
REPLACING SYNTHETIC FERTILIZER WITH GOAT MANURE IN SORGHUM (<i>Sorghum bicolor</i> L.) CULTIVATION	Nanik Setyowati Agung Hendrawan Bambang Gonggo Murcitro Zainal Muktamar Uswatun Nurjanah	Bengkulu University INDONESIA
CHRONIC LIVER FAILURE AND CIRRHOSIS - DIAGNOSIS, CAUSES AND CHARACTERISTICS	Ganiyeva Guney Musa Mustafayeva Nigar Adil Gasimova Tarana Mubariz Dr. Kerimova Rena Jabbar	Azerbaijan Medical University AZERBAIJAN
AIR POLLUTION AND BRAIN TUMOR-RELATED EPILEPSY IN ALBANIA	Florian Dashi, MD, PhD Sabina Cenameri, PhD in Geoscience Tedi Mana	Mother Theresa University Hospital Center ALBANIA Monitoring NL, Fugro, ALBANIA Mother Theresa University Hospital Center ALBANIA
THE SIGNIFICANCE OF REDUCING SULFUR DIOXIDE GAS EMISSIONS FROM OIL REFINERIES: A CASE STUDY OF PETRO RABIGH IN MAKKAH PROVINCE, SAUDI ARABIA	Ahoud Abdullah Mohammed Muhammad Arshad	King Khalid University SAUDI ARABIA
AGROINDUSTRIAL WASTE AS A SUBSTRATE FOR THE PRODUCTION OF MICROBIAL ENZYMES AND A SOURCE OF FERMENTABLE SUGARS FOR THE PRODUCTION OF BIOETHANOL	Terkida Prifti Ilijan Malollari Hasime Manaj	Tirana University ALBANIA

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30.08.2024 | HALL-1 | SESSION-2



London Local Time: 10³⁰-12³⁰



Ankara Local Time: 12³⁰-14³⁰



ZOOM ID: 925 4259 6036 / PASSCODE: 303030

Moderator: Bogdan-Catalin SERBAN

Title	Author(s)	Affiliation
GEROVITAL H3 - A REAL FOUNTAIN OF YOUTH? - PROS AND CONS	Bogdan-Catalin SERBAN Octavian BUIU Marius BUMBAC Cristina-Mihaela NICOLESCU Vlad DIACONESCU	National Institute for Research and Development in Microtechnologies-IMT ROMANIA National Institute for Research and Development in Microtechnologies-IMT ROMANIA
LAETRILE/ AMYGDALIN CONTROVERSY IN CANCER TREATMENT: END OF STORY?	Bogdan-Catalin SERBAN Octavian BUIU Marius BUMBAC Cristina-Mihaela NICOLESCU Vlad DIACONESCU	National Institute for Research and Development in Microtechnologies-IMT ROMANIA Valahia University of Targoviste ROMANIA Valahia University of Targoviste ROMANIA
CARBON NANOHORNS – BASED MATERIALS AS PROMISING SORBENTS FOR EFFICIENT REMOVAL OF VARIOUS CONTAMINANTS FROM WATER	Bogdan-Catalin SERBAN Octavian BUIU Marius BUMBAC Cristina-Mihaela NICOLESCU Vlad DIACONESCU	Valahia University of Targoviste ROMANIA Carol Davila University of Medicine and Pharmacy ROMANIA
JORDAN'S ALMOND & ITS ENVIRONMENT THROUGH ARCHAEOLOGICAL EXCAVATIONS IN JORDAN	Mohammed Waheeb	Hashemite University JORDAN
ANALYZING THE INFLUENCE OF MARBLE WASTE AND FLY ASH SUBSTITUTION FOR SAND ON CONCRETE'S COMPRESSIVE STRENGTH AND WORKABILITY	Saloua FILALI Abdelkader NASSER	Mohammed Premier University MOROCCO
CONSERVATION OF TOURISM RESOURCES IN U MINH HA NATIONAL PARK, VIETNAM	Trong Nhan Nguyen My Tien Ly Viet Dua Phan Tri Thong Truong	Can Tho University VIETNAM Can Tho University VIETNAM Bac Lieu University VIETNAM Nam Can Tho University VIETNAM

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30.08.2024 | HALL-2 | SESSION-2



London Local Time: 10³⁰-12³⁰



Ankara Local Time: 12³⁰-14³⁰



ZOOM ID: 925 4259 6036 / PASSCODE: 303030

Moderator: Dr. Uzma Nadeem

Title	Author(s)	Affiliation
COMMUNITY AWARENESS FOR CLIMATE CHANGE IN ALBANIA	Rudina Çumashi Romina Hala Alba Shima Gentiana Qirjako	Institute of Public Health ALBANIA Institute of Public Health ALBANIA Independent Researcher ITALY Medicine University ALBANIA
FROM CHERNOBYL TO KAKHOVKA: ANALYSIS OF ENVIRONMENTAL AND HEALTH IMPACTS ON GEORGIA	Prof. Dr. Lamara Kadagidze	Grigol Robakidze University GEORGIA
NAVIGATING TOWARDS SUSTAINABILITY: THE ROLE OF GOVERNMENT POLICIES IN PROMOTING ZERO WASTE ENVIRONMENTS	Prof. Harpreet Kaur Dr. Uzma Nadeem	Delhi University INDIA
EVALUATING THE PERFORMANCE OF A FULL-SCALE TRICKLING FILTER FOR MUNICIPAL SEWAGE TREATMENT IN ARID REGIONS: PREDICTING FECAL COLIFORM REDUCTION USING A MULTIPLE LINEAR REGRESSION MODEL	Ahmed Osmane Khadija Zidan Yasmine Jaouad Rabia Benaddi Sbahi soufian Mandi Laila Moustapha Belmouden	Cadi Ayyad University MOROCCO
LOGISTICAL PERFORMANCE AND ECONOMIC VIABILITY OF LOCAL PRODUCT COOPERATIVES IN MOROCCO	Fatima Ezzahra BOUHOUCHE Prof. Saâdia CHABEL	Ibn Zohr University MOROCCO
INVESTIGATING VOLATILITY DYNAMICS IN GREEN BONDS, RENEWABLE ENERGY, AND CRYPTOCURRENCY MARKETS: EVIDENCE FROM DCC MODELING	Ms. Amritha LJ Dr. Jasvinder Kaur Prof. Dr. Satish Menon	SRM University INDIA Kurukshetra University INDIA SRM University INDIA

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30.08.2024 | HALL-3 | SESSION-2



London Local Time: 10³⁰-12³⁰



Ankara Local Time: 12³⁰-14³⁰



ZOOM ID: 925 4259 6036 / PASSCODE: 303030

Moderator: Prof. Dr. Ivan Pavlovic

Title	Author(s)	Affiliation
THE IMPORTANCE OF BUILDING DOG PARKS (ECO ZONES) IN DECREASE POLUTION OF PUBLIC PLACES WITH DOG FACES AND PARASITS	Prof. Dr. Ivan Pavlovic	Scientific Institute of Veterinary Medicine of Serbia, SERBIA
POMOLOGICAL CHARACTERISTICS OF THE OLIVE TREE (OLEA EUROPAEA L.) OF THE PICHOLINE VARIETY CULTIVATED IN THE OLIVE GROWING REGIONS OF MOROCCO	Zaara Nabil	Ibn Tofail University MOROCCO
EXTRACTION OF CAMEL FOOD COLOR: TECHNIQUES, PROCESSES, AND APPLICATIONS	Hajar BENNARI Hassan CHAAIR Soumia BELOUFA	Hassan II University MOROCCO
OPTIMIZATION OF REACTION CONDITIONS FOR α -AMINOPHOSPHONATE SYNTHESIS USING DESIGN OF EXPERIMENTS METHOD	Meriem Ferrah Samia Guezane-Lakoud Mounia Merabet-Khelassi	Badji Mokhtar University ALGERIA
IMPACT OF AMINE ADDITION ON THE DEACYLATION OF BENZYLIC ACETATES	Meriem Ferrah Mounia Merabet-Khelassi Samia Guezane-Lakoud	Badji Mokhtar University ALGERIA
INVESTIGATION OF THE MECHANICAL BEHAVIOR OF AISI 316L AUSTENITIC STAINLESS STEEL AFTER THE JOINING OF AISI 316L AUSTENITIC STAINLESS STEEL USING TIG WELDING METHOD AT 120 AMPER CURRENT INTENSITY	MSc. Tayfun KARAGÖZ Assoc. Prof. Dr. İsmail TOPCU Dr. Ethem İlhan ŞAHİN	Alanya Alaaddin Keykubat Universty TÜRKİYE Alanya Alaaddin Keykubat Universty TÜRKİYE Adana Alparslan Türkeş Science and Technology University TÜRKİYE

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30.08.2024 | HALL-4 | SESSION-2



London Local Time: 10³⁰-12³⁰



Ankara Local Time: 12³⁰-14³⁰



ZOOM ID: 925 4259 6036 / PASSCODE: 303030

Moderator: Assoc. Prof. Dr. Skender Demaku

Title	Author(s)	Affiliation
VASCULAR PLANTS COLONIZATION OF THE HISTORICAL MEDINA OF AZMMOUR, MOROCCO	Mohammed Fassar Jamila Dahmani Meriem Benharbit	Ibn Tofail University MOROCCO Ibn Tofail University MOROCCO National Institute of Archeology and Heritage Sciences, Madinat Al-Irfane MOROCCO
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**NAVIGATING TOWARDS SUSTAINABILITY: THE ROLE OF GOVERNMENT
POLICIES IN PROMOTING ZERO WASTE ENVIRONMENTS**

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Abstract

The idea of zero waste has become widely accepted as a means of achieving sustainable development. The critical role that government regulations play in promoting zero waste settings is examined in this abstract. In order to reduce waste output and its negative effects on the environment, zero waste programs emphasise material reduction, reuse, and recycling. The shift to these sustainable activities may be accelerated by governments with well-crafted legislation. Regulatory frameworks, financial incentives, public awareness campaigns, and support for waste management technology innovation are important policy tools. Regulations provide standards for the treatment and disposal of garbage as well as strict objectives for waste reduction.

Grants and tax exemptions are examples of financial incentives that push people and companies to embrace sustainable practices. Campaigns for public awareness inform the public about the value of recycling properly and reducing waste. The zero-waste goal is further supported by research and development spending, which also encourages advances in waste management techniques. Government policies may successfully mobilise societal efforts towards reaching zero waste settings by incorporating various measures, therefore playing a role in environmental preservation and resource conservation. This abstract emphasises how important it is for governments to have comprehensive, well-coordinated policies in place to lead the way towards a future with zero waste.

Keywords: Sustainable development, Zero Waste, Campaigns, Economy, Policies

ABOUT THE NECESSITY OF MORE SERIOUS ANTHROPOGENIC IMPACT ASSESSMENTS

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PhD – SWU “Neofit Rilski” – Bulgaria

Abstract

The issue of assessing the anthropogenic impact and the problems caused by the development of the world are discussed.

Depending on the characteristics of the different territories (continents), the corresponding living conditions are created, and the different **living beings** (organisms) adapt to the characteristics of these conditions.

In this regard, attention should be paid to **Man**, since he is the only living being on planet Earth that not only adapts to the conditions of the relevant territory, but can also **adapt (change)** them, according to **his needs and interests**, i.e. is anthropogenies them.

Introduction

The meaning and role of this **anthropogenization** has varied throughout the centuries-old history of **Mankind**.

In connection with the above, a comment is necessary on the use of the terms - **urbanization and anthropogenization**.

Usually, the degree of urbanization of a given territory is reported through the so-called coefficient of the urbanized environment. But even with such an approach, anthropogenization is omitted, since urbanization emphasizes the impact of the urban environment, without considering the impact of **Man** on the cultivated agricultural territory.

Usually, the degree of urbanization of a given territory is reported through the so-called coefficient of the urbanized environment.

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Population growth (human population - for more than 30 - 50 centuries before Christ and at least 18 centuries after that) does not significantly affect the processes of planet Earth.

But after the second half of the VIII century (Century of Enlightenment), the human population [<https://www.britannica.com/>] acquires and develops new perspectives, and after the XIX century and the second half of the XX century, the increase in anthropogenic impact (according to the increase in the world population) becomes significant - up to more than 50 times (from the New Year count) (Fig. 1).

What is reflected in Fig. 1 about the dynamics of the anthropogenic impact is quite intriguing and deserves a much more serious assessment - on the one hand in terms of the development of Society, but also in terms of its impact on the state of Nature (the environment).

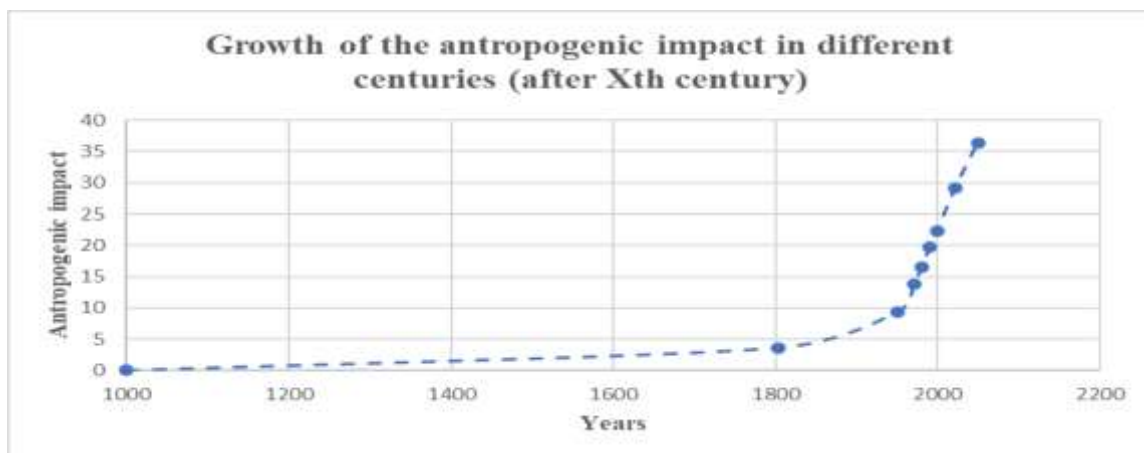


Fig. 1

What is reflected in Fig. 1 about the dynamics of the anthropogenic impact is quite intriguing and deserves a much more serious assessment - on the one hand in terms of the development of Society, but also in terms of its impact on the state of Nature (the environment).

The dynamics of the anthropogenic impact during the different periods of the Society's development - from the X to the XXI century - is impressive.

For example, in the period from the X to the VIII century, this influence (due to the increase in the population) increased about 3.5 times, and in the period from 1800 (the beginning of the VIII century) to 1950 (the middle of the XX century) it increased another 6 times. times (up to about 9.4 times, compared to the X century) and the beginning of the XXI century to about 30 times, compared to the X century.

Results

The difference in the anthropogenic impact in the period after the middle of the XX century is clear.

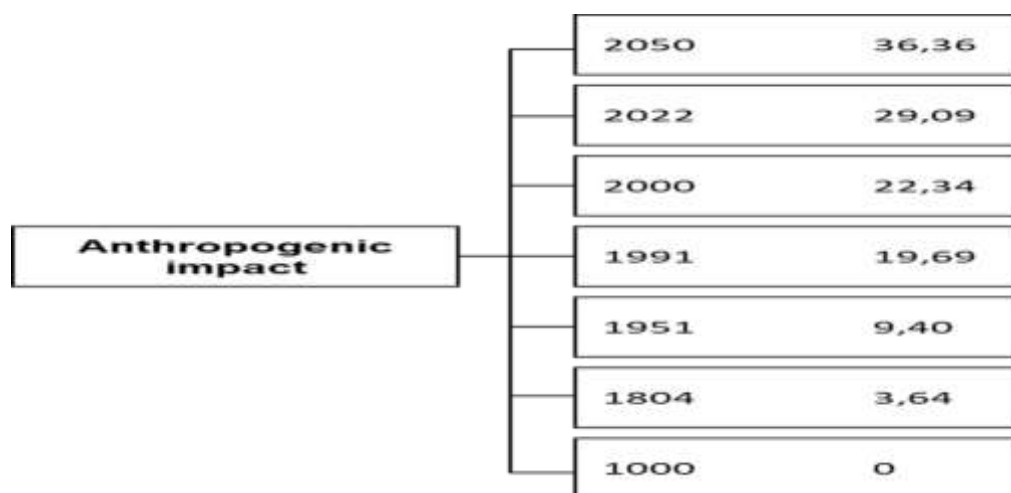


Fig.2 Anthropogenic impact dynamics over the years

A constant upward trend is registered, which is why *it is imperative to pay more serious attention to it*.

Instead of making discussions about *whether (or not) there is a need* of Environmental Protection Activities, it is better to work on ways to establish (regulate) their benefit.

In this regard, it can be proposed (as a possibility) to identify a kind of comparison between the different trends, such as

AIA ↔ **Ew** ↔ **EPA**

Where:

AIA – Anthropogenic Impact Activities,

Ew - Efficiency coefficient for development in the **World**.

EPA – Environmental Protection Activities.

Or in other words, the **AIA** is related to the **EPA** (i.e. one depends on the other), so there is no point in confronting them.

Through the proposed approach (at the local, regional, national, and even international level), an opportunity is created to evaluate the different types of activities - on the one hand, related to increasing anthropogenic impact and on the other, related to environmental protection (for example, *environmentally friendly use of the resources*).

The information from Fig. 1 clearly shows the increasing role of anthropogenic impact, which is a significant indicator of the need for a more serious attitude to the proposed topic.

In practice, two main approaches to anthropogenic impact assessment are applied:

- normative approach or
- analytical approach.

In these approaches, the essential difference is in the basis on which the respective analyzes and assessments are made. In the case of the normative approach, these are the relevant normative documents, while in the case of the analytical approach, the analyzes and assessments are based on the results of the relevant measurements.

The consequences of one or the other approach can be appreciated with an elementary example, if the underestimated information value of the pH indicator is understood.

According to documents for the pH indicator, values from 6 to 9 are regulated, i.e. within these limits, the water complies with the norms and there is no (unacceptable) impact on it. It meets the regulatory requirements.

But - within the limits of the regulatory requirements, an impact of up to 1000 times is allowed, which means that (if we apply the analytical approach) we will be able to establish an impact within the framework of the regulations (fig. 2), which shows the need for a very reasoned explanation of the role of the regulatory documents (fig. 3).

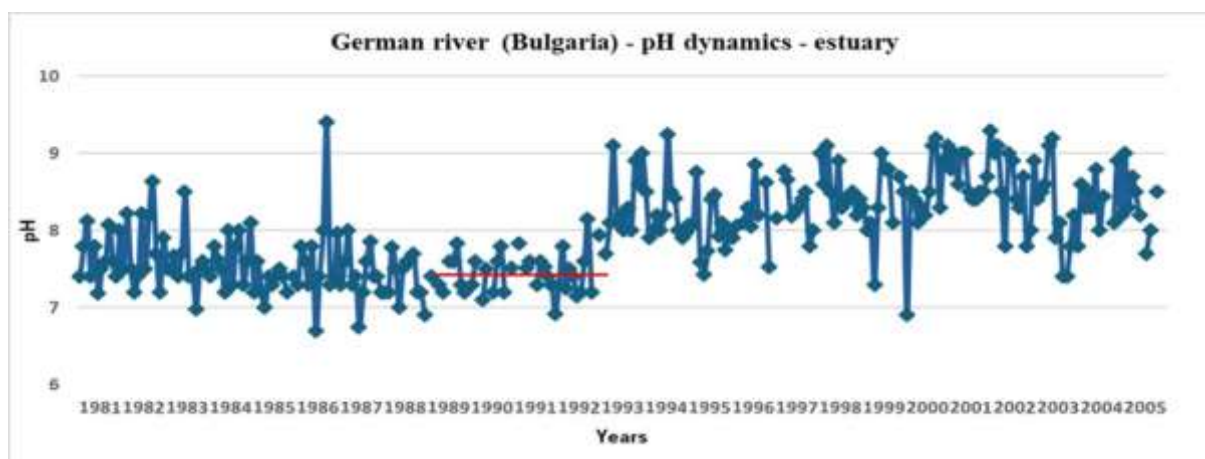


Fig. 2

Through this example, the consequences of applying the two approaches can be easily seen.

By applying the first approach, we establish compliance with the regulatory requirements, but regardless of this (through a more serious analysis of the data from the monitoring systems - (Fig. 2) we register an anthropogenic impact - (for the pH indicator) up to 10 times (within the limits of the regulatory requirements) [Ordinance No. 6, 7 ... - 2000].

In this regard, the Society should reflect on the statements in the creation of the normative documents (commented more than 20 years ago [M.As.Michailov et al., ...-1999] and reflected in Fig. 3) on the assessments of the anthropogenic impact within the limits of the normative requirements.

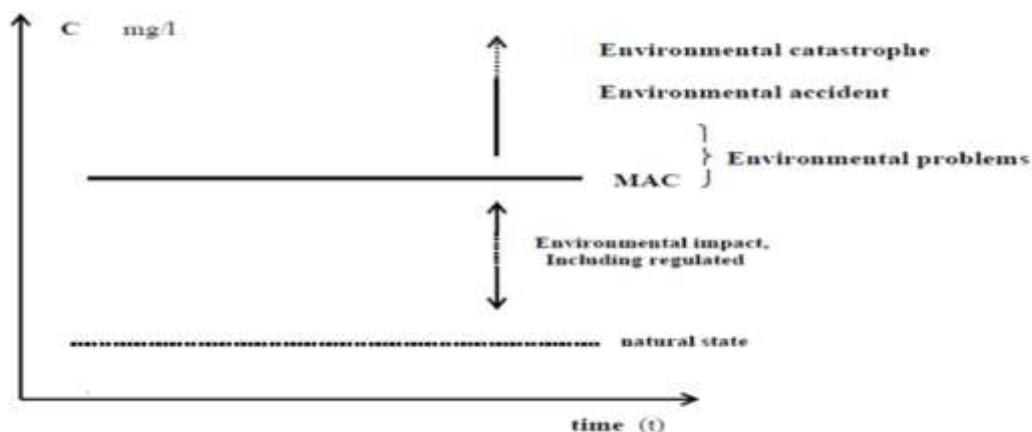


Fig. 3

In relation to the topic under discussion, it is proposed to introduce an index for the assessment of anthropogenic impact (*Iai*), by which to assess the degree of impact on a certain territory

$$Iai = \frac{A}{W}$$

where:

Iai - anthropogenic impact index,

A - anthropogenic intervention - for ensuring water use, for purification and removal of wastewater, for land use (cultivation, fertilization and plant protection), for transport (roads, road and railway infrastructure), for waste treatment (production and domestic), noise, etc.

W – the natural potential of the given territory (water, soil - arable land, pastures, etc., forests, protected territories-reserves, national parks, etc., settlements, etc.).

Through this proposal, an opportunity is created for a more serious (and generalized) assessment of all forms of anthropogenic impact for different territories (both large and small) i.e. the degree of anthropogenic impact can be determined, both global and at regional, even local level.

The development of human society (throughout all centuries) is related to several main factors, which in different periods had the corresponding impact:

- striving to satisfy needs,
- compliance with local conditions (climate, natural features, etc.),
- the development and improvement of the approaches (means, technologies, etc.) to achieve the desired results.

And while for the most part of the past centuries Mankind has complied with the first two groups of factors, after the second half of the XX century the third group of factors became active.

In this sequence, we can answer the question of the need for a more thorough assessment of the consequences of "achieving the desired results" and the increasing anthropogenic impact in recent years - for example, the landfills in (Agbogbloshie) - Ghana [<https://www.worstpolluted.org/>], or (Atacama Desert) - Chile [<https://www.space.com/>], which may look like an experiment (of a scientific-research nature) for a long-term study of waste transformation processes (over time) and finding technological solutions for their further treatment in natural conditions?

It is imperative (for example) to reassess the attitude towards Directive 91/271/EEC, as a basis for interpreting the provisions on "wastewater treatment from settlements" (which have been significantly changed - fig.1 - art.2. p. 6, 7 or 8), since in recent years the anthropogenic impact has been more significant and the requirements for treatment plants set by this Directive should be updated.

Conclusion

Regardless of the presence of many varieties (philosophical movements - anthropocentrism, environmentalism, environmental ethics, etc.) [John Barry (2014), Sofia Guedes Vaz, ...], presence of NGOs and other organizations, it is imperative to note that to define environmental protection activities, it is better to recall the meaning of **Newton's Third Law**, namely - "*for every action (force) in nature there is an equal and opposite reaction*", i.e. in the time of increasingly pronounced **anthropogenic impact**, the corresponding counteraction will inevitably appear, or in other words - the reaction is through **environmental protection activities**.

The object of attention are the negative results of incorrect, unreasonable and insufficiently substantiated (from a scientific point of view) actions of administrative bodies, which are the cause of crisis consequences in the case of natural anomalies.

That is why our proposal is to pay more attention to the **cycle of matter and energy**, through which (especially in its first phase - consumption and production) [*M. As. Michailov – Izmir, 2023*]

If a more serious analysis of the essence of consumption and production is made, we will find that through them the essence of all types of activities in Society is expressed, which (in one way or another) need correction, i.e. in modern society, it is imperative to consider the negative consequences of its actions, which requires realizing the need for environmental protection activities. Not to be implemented as initiatives, but as a conscious activity of the Society (Fig.4), since the anthropogenic impact is ubiquitous and the actions to overcome the negative consequences (of it) require much more serious solutions.

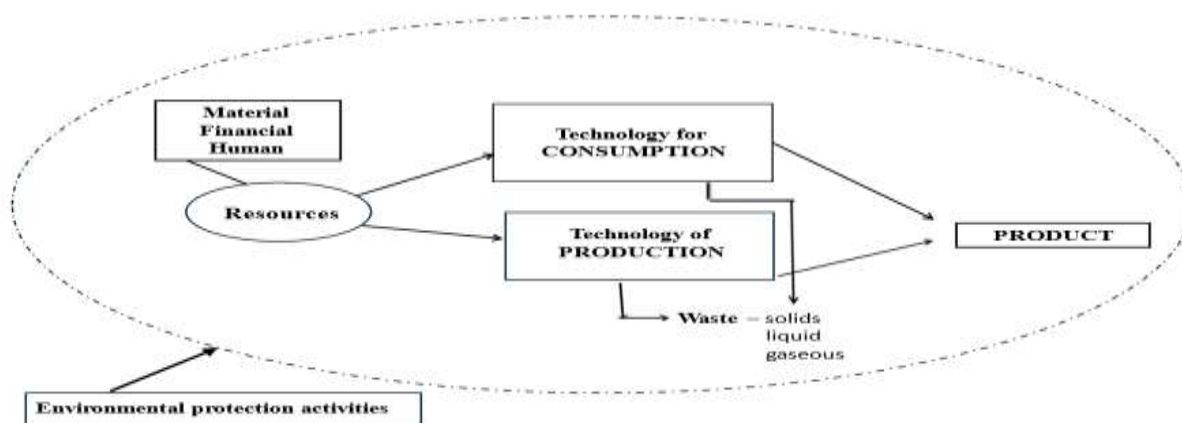


Fig.4

Insight into the essence of the "creation of surplus-value" [Marx K.-1867] is an achievement and it is (perhaps) good to reflect on some points related to the period of development of society in this period (in the VIII century) - "man of his own accord starts, regulates, and controls the material re-actions between himself and Nature" i.e. issues of nature (or the environmental protection) should not be perceived as the "whim-wham" of a part of modern society.

The above requires a re-evaluation of the terminology used.

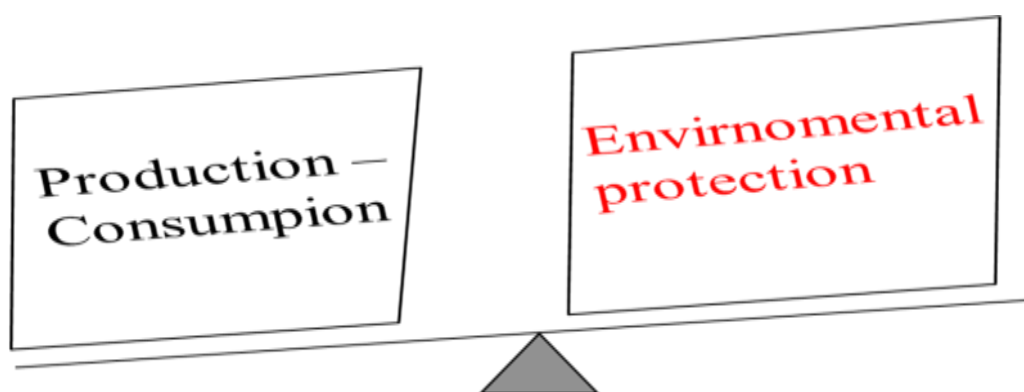


Fig.5

For example, wouldn't it be better to replace the phrase "sustainable development" with another more adequate to modern times, such as "environment-friendly development", through which the

presented proposals for environmental protection activities will "fall into place" and it will not be necessary to explain the benefit of them (Fig.5).

In this connection, we can offer (after corrections) the following *definition*:

society-aware mandatory set of activities (of Man) to limit the role, the negative influence of anthropogenic impact and the consequences of unreasonable (or insufficiently reasonable) actions on the various components of the environment in previous and current stages of development.

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**POMOLOGICAL CHARACTERISTICS OF THE OLIVE TREE (OLEA EUROPAEA L.)
OF THE PICHOLINE VARIETY CULTIVATED IN THE OLIVE GROWING REGIONS
OF MOROCCO**

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Abstract

The Moroccan olive sector is characterized by a great variety of varieties, of which Moroccan Picholine is the dominant variety with nearly 96% of the crops. The objective of this work is the pomological characterization of olives and nuclei of the Moroccan Picholine variety grown in two major regions. The northern region represented by three stations (Tetouan, Chaouan and Ouazzane) and the central region represented by the stations of Settat, Kelaa of the Sraghna and Marrakech. At each site, five trees were sampled with 40 fruits collected per tree. Eleven quantitative characters related to the weight, size and shape of olives and stones are considered and then an indirect estimate of the oil content through the analysis of the pulp percentage (PP) is made. The results obtained have shown that Moroccan Picholine differentiates in the stations studied according to a gradual change in size and of productive potential, the characters related to the form play a secondary role in this differentiation. The olives are large in the Kelaa Sraghna and Marrakech stations, and small in the northern Moroccan stations (Ouazzane and Tétouan). At the other stations (Chaouan and Settat), olives are characterized by an intermediate size. This is explained by the environmental conditions, especially those related to the climate, but also by the nature of the cultivation system. The irrigated system shows larger olives and higher oil content compared to the rain system. These results are in line with the results found during the previous agricultural association (2022/2023) which confirms that the irrigated cultivation system gives good results as regards the weight, size and oil content of the olives compared to the rain-fed cultivation system.

Keywords: Olive Tree, Moroccan Picholine, Regions, Diversity, Climate, Culture System, Pomological Criteria, Oil Content.

**EXTRACTION OF CARAMEL FOOD COLOR: TECHNIQUES, PROCESSES, AND
APPLICATIONS**

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Abstract

Caramel color is widely used in the food industry as a coloring additive, providing an attractive brown hue to various products. This study explores the different techniques and processes involved in the extraction of caramel color, focusing on both traditional and innovative methods of production. The factors influencing the quality of caramel, such as the source of raw material (e.g., cane sugar or beet sugar), operating conditions (temperature, pH, cooking time, etc.), as well as emerging technologies aimed at improving the efficiency and sustainability of the extraction process, are examined in detail. Additionally, the diverse applications of caramel color in the food industry, ranging from beverages to confectionery, are discussed, highlighting the importance of mastering production parameters to ensure a high-quality final product. The findings of this study provide an overview of best practices and innovations in the field of caramel color extraction, while also addressing the challenges and opportunities for the industry.

Keywords: Caramel color, Extraction, Food additives, Innovative technologies, Industrial applications.

**VASCULAR PLANTS COLONIZATION OF THE HISTORICAL MEDINA OF
AZMMOUR, MOROCCO**

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Abstract

Vascular plants growing on Moroccan archaeological sites are considered a factor in the degradation of these sites. The Medina of Azemmour is one of the archaeological sites affected by this biodeterioration. To study these effects, we collected 70 plant species in the historic Medina of Azemmour and analyzed their potential impacts on the substrate. After sampling and identifying the collected plants, we established a list of 70 species, belonging to 26 families. The Asteraceae family is the most represented with 12 species, followed by Poaceae with 7 species, Solanaceae with 5 species and Amaranthaceae with 6 species and Brassicaceae with 4 species. Therophytes are the most represented in the medina of Azemmour with a proportion of nearly 50% followed by Hemicryptophytes which group together nearly 29%, phanerophytes with nearly 13%, geophytes 7% and chamephytes 1%. Spontaneous plants are more represented nearly 66% in this study site. The roots of the plants exert a potential effect on the substrate contributing to the mechanical and chemical degradation of the stones of this monument. Their action can also be physical, by the pressure exerted by the growth of the roots and chemical by the production of acidity and exudates from their rootlets. The search for an effective method of devegetation is necessary to control the development of these plants and reduce the destruction of archaeological sites.

Keywords: Vascular plants, Biodeterioration, historical medina, Azemmour, Archaeology.

**THE NEW CONCEPTION OF GAMMA RADIOLOGICAL SUSTAINABILITY
CONSERVATION AGAINST FUNGI ASSOCIATED WITH ARCHAEOLOGICAL
MANUSCRIPTS IN SAUDI ARABIAN ARCHIVES AND**

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Abstract

The preservation of ancient Saudi archaeological manuscripts housed in various libraries across the country is significantly affected by the indoor environment. Key factors in their deterioration include air pollutants, microbial metabolic byproducts, and microbial excretions. This study focused on identifying and analyzing fungal species responsible for the degradation of 31 deteriorating manuscripts from five different Saudi libraries. The fungi isolated included *Alternaria alternata*, *Aspergillus niger*, *A. flavus*, *Aureobasidium pullulans*, *Mucor heimalis*, *Penicillium chrysogenum*, *P. echinulatum*, *P. expansum*, *P. glabrum*, *P. griseofulvum*, *P. italicum*, *Rhizopus oryzae*, *R. stolonifer*, *Scopulariopsis brevicaulis*, and *Verticillium alboatrum*. *Aspergillus niger* was found to be the most prevalent, with 209 colonies detected. The study assessed the effectiveness of three chemical fungicides (Diniconazole, Rizolex, and Vitavax) and two types of radiation (gamma and ultraviolet) in controlling *A. niger* growth. Results showed that *A. niger* was relatively resistant to chemical fungicides, even at the highest concentration of Diniconazole (4%). In contrast, gamma radiation proved highly effective, completely inhibiting *A. niger* growth at a dose of 3000 Gy across all exposure times. Ultraviolet radiation also reduced *A. niger* growth, though less effectively, with the most substantial inhibition observed at 3000 Gy after 48 hours. Gamma and ultraviolet radiation doses significantly reduced *A. niger's* cellulolytic and pectinolytic enzyme activities, as well as its sugar, total insoluble, and total nitrogen contents. Moreover, nucleic acid content (DNA and RNA) in *A. niger* showed a notable decrease after irradiation, with the most reduction seen in gamma rays. Gamma radiation was the most effective physical conservation method, causing only a 0.5% loss in paper tensile strength compared to an 11.4% loss with ultraviolet radiation. Therefore, gamma radiation emerges as a promising, eco-friendly method for preserving archaeological manuscripts in Saudi Arabia, showing minimal impact on manuscript quality.

Keywords: Fungi, radiation sustainability, archaeological manuscripts and Libraries, Saudi Arabia

**ENERGY MANAGEMENT STRATEGY FOR A HYBRID RENEWABLE ENERGY
SYSTEM COMPRISING PV, WIND TURBINE, BESS, ELECTROLYZER, AND FUEL
CELL: A CASE STUDY IN ESSAOUIRA, MOROCCO**

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Abstract

This paper presents an advanced energy management strategy for a hybrid renewable energy system comprising photovoltaic (PV) panels, a wind turbine (WT), a battery energy storage system (BESS), an electrolyzer, and a fuel cell. The strategy optimizes the use of surplus energy from PV and wind turbines to charge the BESS up to 80% state of charge (SOC) and subsequently directs excess energy to the electrolyzer for hydrogen production. In the event of an energy deficit, the BESS discharges until reaching a 20% SOC, after which the fuel cell supplies the necessary power if the hydrogen tank's SOC is above 20%. The system is modeled and simulated using MATLAB, incorporating real-world data from Essaouira, Morocco, at variable conditions related to consumption and atmospheric condition. This case study demonstrates the effectiveness of the proposed strategy in enhancing energy utilization and storage efficiency, thereby improving the reliability and stability of hybrid renewable energy systems in off-grid locations.

Keywords: fuel cell, Photovoltaic system, hydrogen, Energy management, battery, electrolyser

**"CHEMICAL ANALYSIS OF THE CONCENTRATION OF HEAVY METALS, IN
PARTICULATE MATTER, PM: 2.5 AND PM: 10 MG/M³, IN THE FLY ASH OF: TC
"KOSOVO", COMPLEX "TREPÇA" AND FACTORY "FERRONICELI", IN THE
CITIES: KASTRIOT, MITROVICA, DRENAS AND PRISTINA - CORRELATION WITH
EU STANDARDS"**

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Abstract

Kosovo is a very specific country, geographically, surrounded by all sides with the range, which is fundamentally protected, however, from the influence of the global climate, but in fact, how can this be defined when in many cases we encounter Pristina, as a city that has the primate in the world, of the day-to-day pollution of the environment, what is it that causes all this contamination, with a weak economy, why all this contamination, we have them, they are too weak filters (or have not installed them at all), then old vehicles, forest cutting, lakes contamination, above all, our awareness of a clean environment is lacking, almost `will be ours. Therefore, in this project, we will present our findings, based on chemical analysis, in the cities; Pristina, Mitrovica, Obliq, the cities considered as the most polluted, therefore, the impact on the health of residents and many other environmental impacts, in the areas analyzed will bring a realistic picture of environmental pollution, a perimeter of approximately 60km, including a triangle of the three cities analyzed.

Keywords: Heavy metals; Air, Cars, Households, Thermal power plant

AIR POLLUTION AND BRAIN TUMOR-RELATED EPILEPSY IN ALBANIA

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Abstract

Air pollution poses health risks in several body systems along with adverse effects on brain health, potentially leading to neurological disorders like stroke, cognitive deficits, and neurodegenerative diseases. Studies suggest that air pollution induces oxidative stress, neuroinflammation (NI), alters immune response, affect neural activity, neurobehavioral functions, brain metabolism, and neuronal excitability, which may trigger seizures. Recent research links air pollution to an increased risk of hospitalization or outpatient visits for individuals with epilepsy, emphasizing the need to investigate the direct association between air pollution and epileptic seizures. This understanding may enhance seizure prevention and prediction, improving the safety and health of individuals with epilepsy.

Several studies examined the daily exposure to air pollutants and the risks of clinical and subclinical seizures in epilepsy patients, utilizing long-term seizure records for analysis with little discrepancies in findings that may stem from factors like race, climate, pollution levels, or healthcare standards. Various pollutants like PM10, PM2.5, CO, O3, SO2, and NO2, were positive linked to epilepsy hospitalizations. While CO, SO2 and NO2 were positive associated with epilepsy outpatient-visits, O3 is negative link to epilepsy visits, hinting at a possible potential protective role of the latter. Activities that affect air pollution in Albania are road infrastructure, vehicle fuel quality, uncontrolled burning of urban waste, emissions from construction and combustion of fuel for domestic use. NO2, a significant component of car exhaust, data showed that this component affect neurodevelopment in children and impair nerve function.

Neurosurgical Department in Tirana is the main institution for treating most of the brain tumors in Albania. In our neurosurgical department, 40% of patients hospitalized has their intervention for brain tumors. One of the most common symptoms at presentation are epileptic seizures. In brain tumors, epilepsy commonly persists after surgery, and it tends to be more pharmacoresistant to several antiepileptic drugs (AED). So, most of these patients are followed up regularly almost all their life, so their exposure to environmental factors triggering seizure and air pollutants is high. In collaboration with National Agency of the Environment, we correlated data from the pattern of

distribution of different air pollutants to a pool of patients operated of brain tumors coming from different parts of Albania.

Key words: Symptomatic Seizures, Air Pollution, Pharmaco-resistant Epilepsy.

JORDAN'S ALMOND & ITS ENVIRONMENT THROUGH ARCHAEOLOGICAL EXCAVATIONS IN JORDAN

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Abstract

Jordan's oral tradition, tangible heritage, archaeological excavations and the plethora of sugar mills in the area all clearly indicate that the bite-sized, sugar-coated almonds originated in Jordan. There are 32 sugar mills were discovered in Jordan Valley dating mostly to medieval periods. These mills refer clearly to sugar cultivation, especially in the Jordan Valley area.

The significance of almonds to Christianity is also evidence linking the almonds to the Baptism Site of Jesus Christ on the East Bank of the Jordan River, the team began studying Jordan's almonds in 2020 and pointed out that the Jordanian almonds are among the oldest almond trees in the world.

The choices of delights and sweets are endless, but the "instantly familiar" sugared almonds are part of every festivity, which emphasizes their deep meaning in Jordan's culture and heritage. In weddings, five almonds signify five wishes for the couple: Health, wealth, happiness, fertility and longevity. Jordanian almonds reached Europe through various trade routes, particularly the Incense Trade Route, the old Silk Road & the Elaf Road.

Many scientists and historians said that Jordanian almonds were brought to Europe during the Crusades. Crusaders brought sugar back to Europe from the Holy Land, according to historical resources. Jordanian almonds originated in Shobak, Karak and the Jordan Valley, also noting the archaeological and laboratory evidence demonstrating that the almond trees are almost 7,000 years old. According to field research, Archaeological evidence shows that almond seeds were planted during the Bronze, Iron, Classical and Islamic ages in Jordan.

Many scientists have tried to separate Jordan and Levant from the history of the universally known almonds, but clear archaeological and historical evidence keeps showing the world the truth. Almonds are the future of the Kingdom's environment & agritourism. The candy-coated almonds can be found worldwide but originated in and around the Jordan River and in the Levant.

Keywords: Environment, Almond, Archaeology, Excavations, Jordan River

Introduction

Agritourism is when a farm opens its doors to the public, inviting them to visit and enjoy its agricultural products and services. Many terms reflect the concept of agritourism worldwide; the most common term is 'farm stay'.

Agritourism includes many activities such as: Buying farm produce directly from the farm, wandering through corn mazes, harvesting fruit, feeding the animals, and even staying in the farm's hospitality. Farms open their doors for the public to visit and enjoy the fresh air, relaxation, and

healthy, nutritious produce that is necessarily freshly picked. Some farm owners have introduced agritourism to their farms as a source of additional income, while others do it to teach the general public about farming.

Let us read carefully the reality of the Jordanian almond. Some describe the Jordanian almond, saying: (It is the best almond in the world, and it captures the attention of the West and the East alike, and it shattered the legend of the Greek, Roman, French, Spanish, British, Italian and American almonds, and now sits on the throne of the world almonds, with the recognition of scholars, experts and academics)see (Kirkbride: 1985). Is this an exaggeration? Of course, no it is the future of agricultural tourism in Jordan, which will open its doors to the public and citizens, inviting them to visit it and enjoy its agricultural products and services, accompanied by activities such as buying farm products directly, or wandering in the labyrinths of almond trees, or harvesting almonds directly from the tree, or even staying at the farm hospitality to enjoy the outdoors, relax, and taste the healthy and nutritious Jordanian produce that is necessarily fresh and just harvested from its mother.

Scientists and experts have extensively described the benefits of Jordanian almonds that exceed expectations, and counted them in dozens and more, and today we look at the legacy of our ancestors who loved our fresh Jordanian almonds, plucking them with their blessed hands, and making a shell of the almond tree branch over their heads with love, blessing and other goals.



Figure 1: Almond Garden teers in Jordan cultivated since prehistoric times .

Study Objectives

It is confusing, arouses curiosity, enchants minds, and stirs conscience!

- Are the almonds covered with a layer of colored sugar (Malabbas Aloo), which is called the Jordan almond, which is widespread in most countries of the world, originally from Jordan?
- What is the reason for this wide and surprising spread of the Jordanian almond with its real name in most countries of the world (Jordan's Almond)?
- Why is the Jordanian almond still the best in the world and the dominant one in the occasions of happiness and joy, engagement parties and marriage undisputedly?

- Why is it distributed on happy occasions with five pills representing (happiness, health, longevity, wealth, and fertility) and the Jordanians used to distribute it in the past in the so-called (Mutabbaniya)?
- What is the motive of the Europeans and Americans in general, and the Greeks in particular, in their sleeping habits, saying (that any girl who sleeps and puts Jordanian almonds under her pillow, she will dream of the man she will marry in the coming days)! It is surprising, for what is this Jordanian almond, which carries in its components all these hidden, real, magical, imaginary, and even great powers.

Why did our Jordanian ancestors put a shell of almond branch on their heads?

The Beginning from Jordan

A few months ago, the world recognized that Al-Mahras olives, in Al-Maysir area in the town of Al-Hashmiya in the Ajloun Governorate, are considered one of the oldest genetic strains of olives in the regions of the Mediterranean basin. And it turned out that Al-Mahras olives are the original and oldest within the same genetic group, and the National Center for Agricultural Research published the results of the study in the most prestigious international journals, which brought about a shift in the concept of olive origin and its global spread.

Today, as we are on the steps of a new discovery, the world must admit once again, and even later and repeatedly, that the Jordanian almond is one of the oldest genetic strains of almonds in the world, starting from the blessed land of Jordan in the Mediterranean region and to most countries of the world, from here from the homeland of our ancestors And fragrant history.

- Isn't the land of Jordan blessed and mentioned by the verses of the Noble Qur'an and the honorable Sunnah, isn't it one of the enclaves of Jerusalem, which God blesses around it and its surroundings?
- Did the heavens not open three times here above the land of the Jordan for God's prophets and messengers Elijah/Elias, Jesus Christ, and Muhammad upon them the best prayers and peace.
- Isn't the eastern side of the Jordan River the place where Jesus, peace be upon him, announced that marriage is sacred and inseparable, and perhaps this matter puts an end to the question raised globally, why do they put Jordanian almonds on wedding and wedding tables at wedding parties in Europe and America? .
- Did Jesus not bless the children of Jordan, especially on the eastern side of the Jordan River, in the presence of the crowds and families that rushed and went eager to meet him, and the world repeats the famous saying (here Jesus blessed the children of Jordan).

Where are we from the journey of the Messenger Muhammad, may God's prayers and peace be upon him, when his two honorable feet set foot in the blessed land of Jordan, so he blessed it, passing by the Jordan River, heading to Jerash twice by Khadija bint Khuwaylid on the journey of the (Qurashi Elaf)? Many are in Jordan and his residence here in the shade of its olives, almonds and other blessed trees.

- Then, isn't this the region from which Christianity was spread to all parts of the world? With the recognition of historians, scholars and clerics, this spread was accompanied by the release of the products of the blessed land to the world, such as olives, almonds, dates, grapes and many others.



Fig 2 : Agrotourism in Jordan attract more visitors in Jordan Valley and nearby Districts

The Origin of Almond

And here is the blessing of the Jordanian almonds, spreading to pervade the globe, starting from Jordan. Here is the blessed land with its plants, trees, and people, and it is still giving. Here is the whole world enjoying your blessing with your pure, distinctive, beautiful, and delicious almonds.

Westerners refuse to admit that the almonds of Jordan came from Jordan, and they went looking for places and names in Europe that might help them in justifying the presence of the Jordanian almonds on their lands, and they were confused in the search for the origin of the Jordanian almonds and the secret of its existence and its dominance over all varieties and species in their countries. Some of them said that the name almonds Jordan is a perversion of the name of the city (Verdan) which is located in the north-east of France and then they went and said rather the town of Jardina. In France, too, it is more identical to the word Jordan, then they agreed and agreed with the opinions of scholars and its content that the Jordanian almond may have entered Europe with the Crusaders in the thirteenth century, when the Crusaders in the Middle Ages brought sugar from Jordan to Europe after their campaigns in the Holy Land, where Jordanian sugar was A great value and considered medicinal during that time, and this pharmacist in (French Verdun) began to cover medicinal drugs with sugar (and called them dragee) to facilitate eating them with a sweet taste, but soon the Westerners returned to the difference between themselves and said that the Jordanian almond originated in ancient Rome as well, where it was Presenting almonds covered with honey and then with Jordanian Montreal sugar (Montreal / Shobak) by a Romanian baker and confectioner called (Julius Dragatos). His sweets were called my bikes and were served by nobles and wealthy people at weddings and births. Then, when Jordanian sugar became more readily available in 15th century Europe, nuts were coated with sugar instead of honey. In Italy, the Bellino family perfected the technique of making sugar-coated almonds and called them confetti.

In Spain, the scene is also repeated, but it is clearly evident that the Spaniards have realized the truth and understood that the Arabs were the ones who introduced and cared for almonds in Spain during the days of Islamic rule in Andalusia, and before AD 1500, that is, before the fall of Granada in the

hands of the forces of Queen Isabella and King Ferdinand. The Spaniards and Italians still use Jordanian almonds in the most popular sweets, which is called “turrón” mixed with sugar and others, where they extracted milk from almonds and called “almond milk” that is used in the manufacture of sweets.

Accordingly, the Jordanian almond is an authentic Arab that reached Europe and America and still retains its name to this day:

Among the advantages of the Jordanian almond is that it has seasons, which are:

- The season of green almonds.
- The season of ripe almonds (rubbing).
- Then the dry almonds.



Figure 3: Almond of green and dry types

Name Resolution:

If we go back to analyzing the name of the almond, we will also find that it bears eastern origins, so in the West they call it (Almond), which is a name that comes from the Latin (amandola), which comes from the word (amingdola). This name is scientifically applied to everything that resembles the shape of an almond, taken from the Greek. It seems that the Arabic “al” is the difference in some nouns, and the name was used for the first time from the definition “the” in Italian (mandorla). The English pronounce the name without the word “ah-mond” and the name is pronounced in modern French as “amande”, and while the Turks, Indians, Iranians and Pakistanis call it “Baadaam”, the Arabs call it “almond” which is a name of Aramaic origin from our Arab region. (Lawz - Luz) and some have the name «manj». Almonds are scientifically called *Prunus amygdalus*, which belongs to the peach family *Prunus* of the Rosaceae family, which includes cherries, plums, and others. The available information says, and because the shape of the almond resembles a crescent, voices began to rise that almonds are from the regions of the Levant and the Fertile Crescent, meaning that the origin of almonds goes back to Lebanon, Palestine, Jordan, Syria, and Iraq, and perhaps this new proposition confirms that the Western world is approaching the truth in The name Jordan and almonds (Luz is an Aramaic word) and even the word (Almond) came from the East, so they say

(Jordan's Almond). Therefore, the truth was revealed, and the statement appeared that the origin of almonds is from Jordan, from the land of the Jordan River, and from both banks of the Jordan River. Should we not be proud of this discovery and raise We voted high.(Fig:3.)

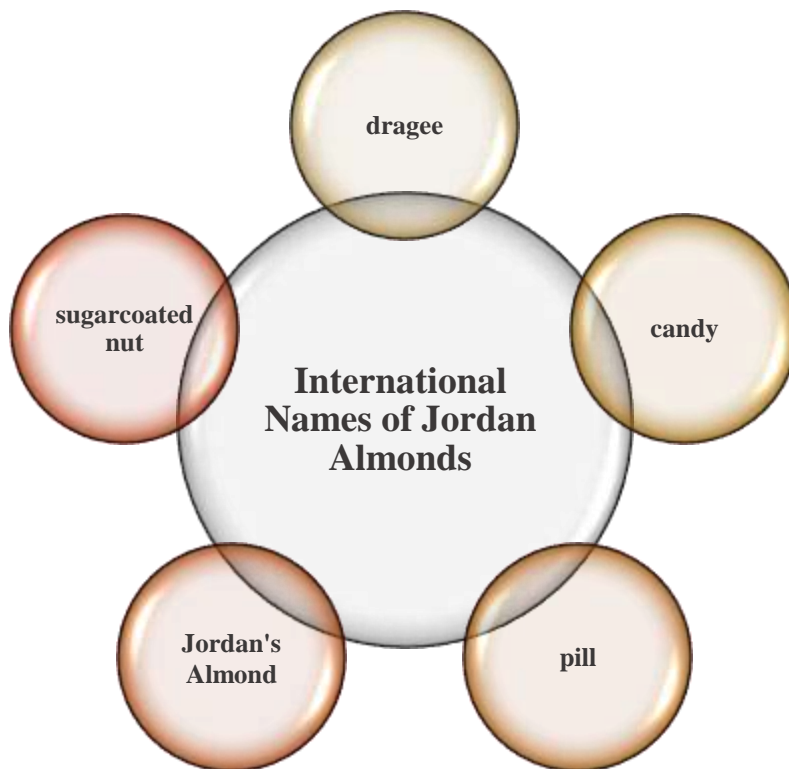


Figure 4 :Almond names in East West Countries.

International Almond Jordanian

The Jordanian almond reached the horizons of the world and in most of its continents, and traces of the almond plant and its kernels were found in the tomb of the pharaoh Tutankhamun, which dates back to the year 1325 BC, and most likely, according to scholars, the pharaohs imported almonds, like many goods, plants and wood from the coasts of Lebanon Palestine and Jordan are nearby. The traces of Jordanian almonds also reached Iceland in the north of the world and near the Arctic Ocean, in addition to Germany.

In Greece, Jordanian almonds are widely used in the manufacture of several types of sweets and foods, especially in wedding and celebration sweets, because of the white color of the heart of the almond and its grain. Almonds are eaten in the Levant countries such as Italy and some European countries, raw green, especially the sweet ones. The available information also says that almonds became one of the most popular plants in North America, before it spread all over the world. Fig:4.

Symbolism of Jordanian Almond.

Jordanian almonds are often used as a wedding gift - like (Italian pomponeer) - as the "bitter" and "sweet" almonds symbolize the bitterness of life and the sweetness of love. Sweets are often grouped into groups of five to represent the five: happiness, health, longevity, wealth, and fertility. In the past, sweets were distributed in the Jordanian cities and countryside in a bowl called

(Mutabbaniyah). In Italian and Greek weddings, almonds are placed in groups of five, an indivisible odd number to symbolize the unity of the spouses, especially in our Arab countries.

Finally, the experts agreed, bowed their heads and bowed their flags, recognizing that the term Jordan almonds referred to is the origin of a variety of almonds originally cultivated along the banks of the blessed Jordan River, which are characterized by long, thin, slender, and somewhat soft kernels in thick and heavy casings, and at a later stage it was exported from Jordan with fine Jordanian Montreal sugar that covers the almond kernels and forms a layer over the almond in the color that the ancestors loved. These almonds were harvested from the trees that were drenched from the fresh water flowing from the slopes of Balqa, Madaba, Karak, Shobak, Tafila, Ajloun and Jerash towards the Jordan River to become the water of the Jordan River Jordan is more sweet, and the Jordanian almond becomes the most famous kind of almond from the blessed land.



Fig 5: Almond still growing in the mountains areas and on the slopy areas

Our ancestors and their story with almonds

Hundreds of years ago, our ancestors had stories with the Jordanian almond in their daily lives that reflected religious beliefs and proverbs.

Almonds were mentioned in the Bible at least ten times, and in some texts it was considered one of the best types of plants, and many eastern and western Christian sects still use almond tree branches to express the virgin birth of Christ, peace be upon him, and a symbol of the Virgin Mary. In ancient times, painters resorted to surrounding the child Jesus Christ with almond branches, and we know that almonds are the first almonds and trees for enlightenment, fruit and giving, and in this, as experts in the Bible point out, God Almighty watches over the comfort of His servants early and takes care of them. Fig:5 .

And in Islam there are references in the Prophetic hadith to the bitter almond stick, its blessing, and its place in alleviating the hardships of man.

The late Jordanian heritage expert Rox Bin Zaid Al-Azizi mentions in his encyclopedia (The Jordanian Heritage Teacher) about honoring trees, saying, “And among the trees respected by Jordanians in the past was the almond tree, because they believed that the prophets took almond

sticks for them. A small piece of almond stick to tie to the back of his headband to protect him from headaches and from bad dreams. Here we find the inherited traditions confirming the authenticity of the Jordanian almond and its universality, which it deservedly reached.

Archaeological discoveries prove that the world's almonds come from Jordan:

Finally, the good news of joy came to the Jordanians with the authenticity of the almonds of their trees and the goodness of their restaurant.

Europeans, Americans, and the world who loved the Jordanian almond, here are the archaeological and laboratory evidence, the descriptions of travelers, ancient and modern historians, the results of scientific research and the inherited traditions from the tangible and intangible heritage. We spoke with news that evokes joy and joy. We have found the main source and the warm homeland of the Jordanian almond, and here are the material and intangible evidence confirming We have no doubt that we are in front of the truth that we must face. **(Rollefson, and Simmons:1985) see also (Kafafi:1988)**

The results of laboratory tests indicated that the people of Jordan had planted almonds, which they loved, more than seven thousand years BC, which is equivalent to nine thousand years from the present day. This legacy is deeply rooted in the roots of history that lights us the candle of guidance to reach the truth. **(Harlan:1982)**

- The Jordanian almond seed appeared in the sites of the first human settlement during the Stone Ages in the Jordan Valley and the highlands through the results of archaeological excavations. **(Parker:2002)**
- Also, the Jordanian almond seed appeared during the excavations at the site of TabqatFahl and in Iraq Al-Dib in Ajloun, in Ghor Al-Safi, Ain Ghazal **(Rollefson and Simmons :1985)**, here and there and wherever you went and went on the land of the blessed kingdom.**(Philup,c,Steven,e,Patricia et al:2002)**
- Evidence, especially almond seeds, were discovered during the Bronze, Iron, Classical and Islamic ages without interruption. **(Deckers, 2010)**
- The results of these archaeological discoveries were also published in scientific journals specialized in archaeology and environment in various countries of the world and in several languages.

Conclusion

- Jordanian almonds originated in Shobak, Karak and the Jordan Valley, the archaeological and laboratory evidence demonstrating that the almond trees are almost 7,000 years old.
- “Archaeological evidence also shows that almond seeds were planted during the Bronze, Iron, Classical and Islamic ages in Jordan,” according to archaeological evidence. **(Flangan, McCrery & Yassein:1995)**
- “Many scientists tried to separate Jordan from the long history of the universally known almonds, but the very clear archaeological and historical evidence keeps showing the world the truth,

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FROM CHERNOBYL TO KAKHOVKA: ANALYSIS OF ENVIRONMENTAL AND HEALTH IMPACTS ON GEORGIA

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Abstract

The present paper investigates the ecological and public health consequences of two major environmental disasters affecting Georgia: the Chernobyl nuclear disaster and the Kakhovka Dam explosion. The 1986 Chernobyl disaster released significant radioactive contamination, with long-term repercussions that have manifested in elevated cancer rates and other health issues among Georgia's population. The 2022 Kakhovka Dam explosion introduced new environmental hazards, potentially affecting water quality, soil integrity, and air quality in the Black Sea region. The comparative analysis addresses both the similarities and distinctions in the environmental degradation and health outcomes resulting from these events. The article explores the extent of contamination of natural resources, the ecological disruptions, and the epidemiological patterns associated with exposure to hazardous substances. It also discusses the broader implications for disaster response strategies, policy development, and public health infrastructure in Georgia. By drawing parallels between these two events, the study emphasizes the significance of historical context in understanding and managing current and future environmental challenges. The findings offer critical insights for researchers, policy makers, and public health professionals, advocating for enhanced environmental monitoring and health surveillance systems.

Key words: Chernobyl Disaster; Kakhovka Dam Explosion; Black Sea Region, Georgia; Environmental Impact; Public Health; Ecological Impacts of Armed Conflicts; Comparative Analysis.

Introduction

Environmental disasters often have far-reaching consequences, affecting regions far beyond their points of origin. The present article explores the environmental and health impacts of two such catastrophic events—the Chernobyl nuclear disaster of 1986 and the Kakhovka Dam explosion of 2022—on the country of Georgia. The Chernobyl disaster, one of the most severe nuclear accidents in history, released radioactive material that has had long-lasting effects on the environment and public health, with significant repercussions for Georgia (Mandzhgaladze & Shavdiya, 1996; Cardis et al., 2006; Gamkrelidze, 2018; Urushadze & Manakhov, 2017). Decades later, the explosion of the Kakhovka Dam, a direct result of the ongoing Russian-Ukrainian war, has introduced new environmental challenges (Vyshnevskiy et al., 2023). This disaster threatens the ecological stability of the Black Sea region, which includes Georgia, potentially impacting water quality, soil health, and air purity (Zheleznyak et al., 2022).

The destruction of the Kakhovka Dam raises significant concerns under international humanitarian law (IHL). According to Dannenbaum (2023), the dam's explosion not only exemplifies a severe breach of IHL concerning the protection of civilian infrastructure but also highlights its implications for civilian survival and environmental integrity. The dam, considered an object indispensable to civilian survival, was subjected to destruction that contravenes the legal protections afforded under Article 54 of Protocol I, which prohibits attacks on objects critical to the survival of civilians (Dannenbaum, 2023). This analysis underscores the broader implications of such man-made environmental disasters, emphasizing the need for robust legal frameworks to safeguard civilian and environmental welfare during conflicts.

The paper aims to provide a comparative analysis of these two disasters, examining their environmental degradation and health impacts on Georgia. By drawing parallels between the Chernobyl disaster and the Kakhovka Dam explosion, it seeks to contribute to a broader understanding of how both historical and recent environmental catastrophes shape the health and well-being of populations far beyond the immediate disaster zones (IAEA, 2006). Understanding the long-term effects of environmental catastrophes on human health and the environment is crucial for several reasons. Firstly, such disasters often result in immediate and severe ecological damage, with the release of harmful substances into the air, water, and soil that can persist for decades, affecting multiple generations (Pahwa, 2023). In Georgia, the fallout from Chernobyl has led to an ongoing public health crisis, with elevated cancer rates and other radiation-related illnesses still prevalent today (Gamkrelidze, 2018; Cardis et al., 2006). The Kakhovka Dam explosion, a consequence of the Russian-Ukrainian war, emphasizes the continued relevance of studying these events, as it highlights the vulnerability of the environment and human health to man-made disasters (IAEA, 2006).

Secondly, studying these catastrophes can inform disaster preparedness and response strategies, helping to mitigate the impact of future events (UNEP, 2023). Lessons learned from the Chernobyl disaster have shaped global nuclear safety protocols, yet the ongoing effects in regions like Georgia indicate that more needs to be done to protect populations from similar risks (Tronko et al., 2012). The Kakhovka Dam explosion, while recent, is already prompting discussions on how to address and remediate the damage, ensuring that affected communities receive the support they need to recover (Zheleznyak et al., 2022).

Lastly, this research is essential for policy-making, providing evidence-based insights that can drive legislative and regulatory changes (Dannenbaum, 2023). For Georgia, a country that continues to experience the consequences of both past and recent environmental disasters, such research is vital for ensuring that future policies prioritize public health and environmental sustainability (Ivanov et al., 1999; Tronko et al., 2012).

Background

Overview of the Chernobyl Disaster

The Chernobyl disaster, which occurred on April 26, 1986, at the Chernobyl Nuclear Power Plant in Ukraine (See Figure 1.), is widely regarded as one of the worst nuclear accidents in history. The explosion at Reactor No. 4 released vast amounts of radioactive material into the atmosphere, leading to widespread environmental contamination and long-lasting health consequences. The immediate aftermath saw the evacuation of nearly 350,000 people from the most affected areas, and the establishment of a 30-kilometer exclusion zone around the plant, which remains uninhabited to this day.

Figure 1.



Image Source: ArcGis StoryMAPs

Geographic and Environmental Context Relevant to Georgia

While the epicenter of the disaster was in Ukraine, the radioactive fallout spread across much of Europe, with Georgia being one of the affected countries due to its geographical proximity. The Black Sea region, in particular, experienced significant contamination, with radioactive particles being carried by wind and water currents. The agricultural lands, water sources, and even the urban areas of Georgia faced varying degrees of radioactive contamination, impacting both the environment and public health. This geographic context is crucial in understanding the long-term effects that Georgia has endured since the Chernobyl disaster, including the rise in cancer rates and other health issues that have been observed in the population over the decades.

Overview of the Kakhovka Dam Explosion

On June 6, 2023, the destruction of the Kakhovka Dam in Ukraine resulted in a severe ecological disaster, impacting both the environment and human communities (See Figure 2.). The explosion, which drained the dam's reservoir into the Dnieper River, caused extensive flooding across a 50-mile stretch, inundating lands, infrastructure, and homes with polluted runoff (Pahwa, 2023). This runoff included hazardous substances such as pesticides, chemicals, oil, and potentially toxic materials from burial sites.

The disaster led to significant losses, including the death of thousands of animals, both in the wild and in captivity, and substantial damage to Ukrainian agriculture and industry. The flooding affected about 125,000 acres of forest and caused the death of numerous fish and wildlife. Additionally, the dam's destruction poses long-term risks to the Zaporizhzhia Nuclear Power Plant by diminishing its water reserves, which could result in a severe energy crisis (Pahwa, 2023).

The environmental repercussions extend beyond Ukraine, potentially affecting neighboring countries such as Bulgaria, Romania, Turkey, and Georgia, which rely on the Black Sea for various economic activities. The pollution and ecological damage from the dam's collapse are expected to have lasting effects on regional water quality and biodiversity (Pahwa, 2023).

Figure 2.



Image Source: The Economist: “Huge explosions breach the Kakhovka dam in southern Ukraine”

Geographic and environmental context related to the Black Sea region

The Kakhovka Dam, located on the Dnieper River, was a crucial structure in Ukraine, not only for its role in water management and energy production but also for its influence on the broader ecosystem of the region. The Dnieper River flows into the Black Sea, making the dam's destruction particularly concerning for countries bordering this vital body of water. The Black Sea is a shared resource among several nations, including Ukraine, Russia, Georgia, Turkey, Romania, and Bulgaria. It supports a range of economic activities such as fishing, tourism, and shipping, and is home to diverse marine ecosystems.

The dam's collapse and the subsequent flooding released a large volume of contaminated water into the Dnieper River, which eventually made its way into the Black Sea. This influx of pollutants, including industrial chemicals, pesticides, and other hazardous materials, poses a significant threat to the water quality and marine life in the Black Sea. The potential spread of these contaminants could lead to ecological degradation, affecting fish populations, disrupting food chains, and threatening the livelihoods of communities dependent on the sea.

For Georgia, which relies heavily on the Black Sea for both economic and environmental reasons, the impact could be particularly severe. The pollution could affect coastal regions, leading to a decline in water quality, affecting fisheries, and potentially harming tourism. Moreover, the ecological balance of the Black Sea is delicate, and the introduction of toxic substances could have long-lasting effects on biodiversity. The potential for these pollutants to accumulate and cause further environmental harm underscores the interconnectedness of regional ecosystems and the need for collaborative efforts in monitoring and mitigating the disaster's impact.

This context highlights the far-reaching consequences of the Kakhovka Dam explosion, not only within Ukraine but also for the entire Black Sea region, including Georgia. It sets the stage for understanding the broader ecological and economic challenges that arise from such environmental disasters and the importance of regional cooperation in addressing them.

Environmental Impacts

Impact on Water

The article by Vyshnevskiy, Shevchuk, Komorin, and Gleick (2023) provides an in-depth analysis of the destruction of the Kakhovka hydropower plant and its profound consequences. Occurring on June 6, 2023, amidst the Russia–Ukraine War, the destruction resulted in severe flooding of cities and villages along the Dnipro River, causing extensive damage and loss of life (See Figure 3. and Figure 4.). Key aspects covered include: The release of oil and other toxic substances into the Black Sea threatens marine life, potentially leading to mass deaths among aquatic organisms, especially during sensitive developmental stages. Increased salinity and hypoxic conditions could further stress the marine ecosystem, with long-term effects including secondary pollution, bioaccumulation of toxins, and disruptions to biodiversity and habitat.

Figure 3.



Image Source: Center for Civilians in Conflict: “Destruction of Kakhovka Dam Is a Devastating Blow for Civilians in Ukraine”

The authors discuss potential restoration strategies for the Kakhovske reservoir. They suggest constructing a temporary dam to restore minimal water levels while planning for a new hydropower plant with increased capacity. The restoration aims to address disrupted water supplies and land irrigation, essential for agricultural and industrial needs. The paper references historical instances of dam destruction during conflicts, including World War II, and discusses the evolution of international humanitarian laws prohibiting attacks on water infrastructure due to their severe impact on civilian populations.

Figure 4.

Image Source: U.S. Embassy & Consulates in Russia

“U.S. sends aid to Ukraine following destruction of Kakhovka Dam”

The recent destruction of the Nova Kakhovka dam in Ukraine has raised concerns about potential environmental hazards in the Black Sea, including the possibility of contaminants reaching Georgian shores. Following the dam's collapse on June 6, significant amounts of oil, chemicals, and other pollutants were released into the Black Sea, which led to heightened fears among coastal communities in Georgia. Despite public apprehension, Georgian authorities and environmental experts have reported that there are no significant signs of increased pollution in the Black Sea waters along Georgia's coastline (Gabritchidze, 2023). The National Environmental Agency (Georgia) has been actively monitoring water quality, with recent reports indicating that concentrations of biological elements, heavy metals, and hydrocarbons are within acceptable limits. On August 23, 2024, the National Environment Agency further confirmed that the latest monitoring results show the water is safe for swimming, with no deviations from required standards along the entire coastline. Regular analysis conducted at 12 locations along the coast revealed that the water quality meets all required standards, including assessments of heavy metals, petroleum hydrocarbons, and other chemical parameters. The agency's accredited laboratory, equipped with modern tools, ensures comprehensive monitoring. In line with the EU Marine Strategy Framework Directive, efforts are ongoing to enhance the monitoring system, ensuring even more detailed assessments in the future (NEA, 2024). Following the dam collapse, there were reports of dead dolphins and livestock washing ashore, which heightened local fears about water contamination. However, these incidents were attributed to natural occurrences and local flooding rather than direct effects of the dam collapse. Experts suggest that the Black Sea's vast volume and circulation patterns mean that pollutants from the Kakhovka dam are unlikely to reach Georgian shores in significant amounts. The pollutants would first affect the coastlines of Romania, Bulgaria, and Turkey before potentially reaching Georgia. The perception of contamination has affected tourism (Kadagidze & Piranashvili, 2024), with some cancellations reported. The Georgian government is working to reassure tourists and the public by maintaining rigorous water quality monitoring and engaging in information exchange with neighboring countries. Continuous monitoring is necessary to assess any long-term effects on the Black Sea's ecosystem, particularly concerning the safety of commercially caught fish and the health of biodiversity in the region (Gabritchidze, 2023).

Impact on Soil

Bilgiç and Gündüz (2022) conducted a comprehensive radiological analysis of the Chernobyl Nuclear Power Plant (CNPP) accident's impact on southeast Europe, with a specific focus on Turkey, Armenia, Georgia, and Iran. Utilizing the FLEXPART model, their study estimated atmospheric dispersion and ground deposition of radionuclides, particularly ^{137}Cs , from the CNPP accident. The study found the highest ^{137}Cs deposition in the Eastern Black Sea region, including parts of Georgia, with values ranging from 10 to 40 kBq/m². This was significantly higher compared to other regions like Armenia and Azerbaijan, where average ^{137}Cs depositions were below 10 kBq/m². The radiological modeling indicated that soil contamination in Georgia was substantial, with notable implications for agriculture and land use in the affected areas. The study's results highlighted the critical need for localized assessments of soil contamination to understand fully the environmental impacts in Georgia. The one-year TEDE was generally less than 1 mSv across most regions, except for the eastern Black Sea area, where it was higher. Lifetime dose values were particularly elevated along the Black Sea coasts of Georgia, indicating long-term radiological exposure concerns.

These findings underscore the significant impact of the CNPP accident on soil in the southeastern Black Sea region, including Georgia, and emphasize the need for ongoing environmental monitoring and assessment.

The Chernobyl nuclear disaster of 1986 resulted in significant radioactive contamination of soils in Georgia, a situation further compounded by ongoing anthropogenic sources of radioactivity. Urushadze and Manakhov (2017) highlight that artificial radioactivity, particularly from strontium-90 (^{90}Sr) and cesium-137 (^{137}Cs), has been a major concern due to its persistence and biological impact. These radionuclides, which accumulate in soil and subsequently in agricultural products, continue to affect soil quality and agricultural production in Georgia (Urushadze & Manakhov, 2017). Their study found that contamination levels vary regionally, with the highest concentrations of ^{137}Cs observed in western Georgia, particularly along the Black Sea coast, while high mountain regions exhibit lower contamination levels. This regional variability underscores the lasting impact of the Chernobyl disaster and the ongoing relevance of assessing soil contamination to understand its long-term environmental and health implications for Georgia (Urushadze & Manakhov, 2017).

Impact on Air

The Chernobyl Forum's report on the environmental consequences of the Chernobyl accident provides detailed insights into the impact on air quality. The report highlights two main sources of radioactive aerosol releases from the Chernobyl site: controlled releases through ventilation stack No. 2 and uncontrolled releases through leaks in the shelter's structure.

At the time of the report, controlled releases from the ventilation stack were measured at 4–10 GBq annually, which was well below the regulatory limit of 90 GBq per year. Uncontrolled releases, which varied based on environmental conditions such as temperature and wind, contributed to higher localized contamination.

The report indicates that, near the shelter, the air contained finely dispersed fuel particles with concentrations of up to 40 mBq/m³ of ^{137}Cs within 1 km and 2 mBq/m³ at around 3 km. These particles primarily consisted of beta emitters like ^{90}Sr and ^{137}Cs , and alpha emitters such as plutonium and ^{241}Am . The report estimated that the inhalation dose for someone spending an

entire year close to the shelter would be approximately 0.5 mSv, which dropped to around 0.0002–0.0005 mSv beyond 10 km from the shelter.

The findings emphasize that, despite ongoing releases, the air quality outside the Chernobyl Exclusion Zone (CEZ) had decreased significantly and remained below the regulatory limits for public health (Chernobyl Forum, 2006) (See Figure 5.).

The "Rapid Environmental Assessment of Kakhovka Dam Breach, Ukraine, 2023," published on October 25, 2023, provides a detailed evaluation of the severe and likely irreversible environmental impacts resulting from the breach of the Kakhovka Dam in June 2023. This assessment, conducted by a coalition of 13 institutions, underscores the extensive and long-lasting effects on both upstream and downstream ecosystems and human health. The report highlights that the breach has caused significant changes to hydrology, geomorphology, and ecology in the affected areas. These impacts include widespread chemical contamination, accumulation of waste, and damage to protected areas. The assessment notes that these consequences will be felt for decades, emphasizing the severity of the damage (UNEP, 2023). While the assessment covers numerous environmental damages, it does not address all potential impacts, such as those on irrigation, drinking water supplies, or water needed for industrial uses, including the Zaporizhzhia Nuclear Power Plant. The exclusion of these aspects indicates that the full extent of the breach's effects on human health and infrastructure requires further investigation (UNEP, 2023). The report calls for urgent external financial and technical support to facilitate effective remediation and restoration efforts. This breach is part of a larger pattern of environmental damage resulting from ongoing conflict, necessitating continued assessments and substantial funding to address the full scale of environmental and health impacts (UNEP, 2023).

Figure 5.



Image source: Quora: "Did the people really taste the metal in their mouth at Chernobyl disaster (26 April 1986)?"

Ecological Impact of the Russia-Ukraine Conflict

The ongoing conflict between Russia and Ukraine has inflicted profound human suffering and economic damage and led to significant ecological harm. Zheleznyak et al. (2022) detail the war's environmental degradation, including soil and water contamination from weaponry and pollutants,

the destruction of ecosystems, and the heightened risk of large-scale nuclear disasters, particularly around the Zaporizhzhia Nuclear Power Station, the largest in Europe.

Accurately assessing the long-term environmental damage during wartime presents a formidable challenge, as noted by Zheleznyak et al. Efforts by the Ukrainian government, such as the establishment of the Operational Headquarters of the State Environmental Inspectorate, play a crucial role in cataloging war damages. However, the ongoing conflict and limited resources constrain the scope of these assessments. The authors advocate for international scientific collaboration, urging researchers and funding institutions to develop decentralized projects to evaluate ecological impacts and support remediation efforts. Their findings underscore the necessity for comprehensive studies to understand and mitigate the environmental consequences of military conflicts, offering a potential framework for managing wartime environmental damage globally.

Health Impacts

The health implications of environmental disasters are starkly illustrated in studies on the Chernobyl disaster (See Figure 6.). Cardis et al. (2006) evaluate the cancer burden in Europe due to radioactive fallout from the Chernobyl accident on April 26, 1986. Using updated dosimetric models and radiological data, the study estimates that Chernobyl may have caused approximately 1,000 thyroid cancer cases and 4,000 other cancers in Europe, with projections suggesting that by 2065, these numbers could rise to 16,000 thyroid cancer cases and 25,000 other cancers. Although these estimates carry significant uncertainty, they highlight the profound yet often obscured health burden of the Chernobyl disaster, particularly concerning thyroid cancer in the most affected regions.

Further illustrating the health impact, Tronko et al. (2012) investigated thyroid cancer rates in Ukraine following the Chernobyl accident through the Ukraine-American Thyroid Project (UkrAm). This extensive study, involving multiple screening cycles, revealed a significant increase in thyroid cancer rates among individuals exposed to radioactive iodine, with 94.5% of the identified cases being papillary carcinomas. This research underscores the severe consequences of radioactive exposure on public health, particularly in heavily contaminated areas of Ukraine.

Gamkrelidze (2018) explores the long-term effects of the Chernobyl nuclear accident on leukemia rates in Georgia. Despite inconsistencies in epidemiological data, the study highlights a troubling increase in leukemia incidence in Georgia, particularly in regions with high levels of radioactive contamination. While earlier studies showed varying results in neighboring countries, the situation in Georgia, particularly along the Black Sea coast, has been less studied. Gamkrelidze notes that leukemia rates in Georgia increased by 100% between 1988 and 1992, with a continued rising trend since 2011. However, the lack of consistent correlation between leukemia rates and Chernobyl contamination levels suggests that other factors may also be contributing to the observed health outcomes.

Figure 6.



Image Source: The Mirror: “Chernobyl survivors describe horror symptoms they are STILL suffering 37 years later”

Potential Health Risks from the Kakhovka Dam Explosion

The recent explosion of the Nova Kakhovka dam has raised concerns about potential health risks similar to those seen after Chernobyl. Initial assessments indicate that the explosion could have far-reaching health implications, particularly concerning water contamination and the subsequent impact on communities relying on these water sources.

According to Schmeier and von Lossow (2023), the destruction of the dam has not only devastated the immediate environment but has also had severe repercussions on the civil population. The floods resulting from the dam's collapse have displaced thousands of people, killed livestock, and destroyed homes and critical infrastructure (See Figure 7.). In areas like Kryvyi Rih, where 70% of the drinking water supply depended on the Kakhovka reservoir, the situation is dire, with drinking water provision severely challenged.

The Ukrainian government has warned of the increased risk of water-borne diseases due to the contamination of wells and lakes by germs and chemicals in the floodwater. Additionally, Ukrainian authorities and the Red Cross have raised alarms about land mines displaced by the floodwaters, turning them into floating mines that could endanger other areas, including villages and cities.

Future studies will be essential to monitor the long-term health impacts of this disaster, drawing comparisons with similar events like Chernobyl to better understand the potential risks and inform public health responses.

Figure 7.



Image Source: IHE DELFT Institute for Water Education: Key insights into the Nova Kakhovka dam destruction: An initial analysis.

Comparative Analysis

Both the Chernobyl disaster and the Russia-Ukraine conflict share common factors in their impact on Georgia's environment and population. The contamination of land and water, the disruption of ecosystems, and the long-term health effects, particularly concerning cancer and other radiation-induced illnesses, are evident in both cases.

However, the scale and nature of the two incidents differ significantly. While Chernobyl's impact was primarily radiological, the ongoing conflict in Ukraine presents a multifaceted environmental disaster involving chemical, radiological, and ecological degradation. The immediate health risks from the Kakhovka dam explosion, although less understood, may be less severe in scope but potentially longer-lasting due to ongoing conflict and environmental neglect.

The insights gained from these events offer valuable lessons for disaster preparedness and response. The interview with Nino Chkhobadze, a former Minister of Environment and Natural Resources Protection of Georgia, provides critical insights into the management of radioactive materials in Georgia, particularly in the context of post-Soviet military activities and the risks posed by regional nuclear facilities. Chkhobadze highlights the historical efforts to locate and safely store radioactive waste, emphasizing the importance of ongoing public awareness and stringent monitoring to prevent future contamination. She also discusses the potential environmental threats from nearby nuclear power plants, such as the Metsamor plant in Armenia and Turkey's planned nuclear reactors, which could impact Georgia, especially in terms of water contamination from the Black Sea. Chkhobadze underscores the need for international cooperation and robust safety protocols to mitigate these risks, drawing on past experiences with Chernobyl and other radiation incidents to inform current and future disaster preparedness strategies (Chkhobadze, 2024).

Conclusion

This comparative analysis has highlighted the profound ecological and health impacts of the Russia-Ukraine conflict, drawing parallels with the Chernobyl disaster. Both events underscore the

importance of comprehensive assessments and international collaboration in managing the long-term consequences of environmental disasters.

The destruction of the Nova Kakhovka dam likely violates multiple international humanitarian law provisions, including those related to protecting indispensable objects and the natural environment (Dannenbaum, 2023). While the thresholds for war crimes are demanding, the act could implicate specific war crimes related to attacks on dams and environmental damage. The "Emissions Gap Report 2022" parallels the need for systemic changes to mitigate climate impacts with the necessity for comprehensive remediation and response strategies for environmental disasters like Chernobyl and Kakhovka. Both scenarios highlight the importance of large-scale, proactive measures to address and prevent significant environmental and public health risks.

Reflecting on these events, the importance of ongoing research and vigilance in monitoring the long-term impacts of environmental disasters cannot be overstated. For Georgia, the lessons learned from Chernobyl and the current conflict in Ukraine should inform future policies and strategies, ensuring that the country is better prepared to face and mitigate the consequences of such disasters.

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**THE SIGNIFICANCE OF LOWERING SULFUR DIOXIDE GAS EMISSIONS FROM
OIL REFINERIES: A CASE STUDY OF PETRO RABIGH IN MAKKAH PROVINCE,
SAUDI ARABIA**

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Abstract

Air Pollution is the third largest cause of death after high blood pressure and tobacco use and should be monitored and dealt with in the same seriousness as COVID-19 pandemic. Recently, due to environmental and climate change concerns, stricter international environmental standards require sulfur content should not to exceed 10 ppm in gasoline production. Countries including Saudi Arabia are working to lower sulfur levels in crude oil. The Petro-Rabigh refinery in Makkah has reported that its sulfur reduction unit (SRU) can remove 108,000 tons of sulfur from its crude oil to meet stricter international specification standards. This research uses the Google Earth Engine (GEE) to verify this claim by analyzing sulfur dioxide data from the TROPOMI sensor on the Sentinel-5P satellite which has a Daily revisit time. The GEE results support the reduction of sulfur content in gasoline production. However, further research is needed to confirm this assertion.

Key Words: Pollution, crude oil, air pollutants, Sulfur Reduction Unit, Google Earth Engine, TROPOMI sensor.

INTRODUCTION

Air pollution is considered one of the biggest issues that are threatening humans, animals, and wildlife, Air Pollution is responsible for 6.7 million premature deaths every year.

The incomplete combustion of fuels and chemical reactions between Gases led to an increase in the ratio of Air pollutants in the whole world, for example, Lighting Kerosene, Industries and heating with dirty technologies contribute to contaminating the Air.

Pollutants for public health concern include Carbon monoxide (CO₂), Ozone(O₃), Nitrogen (NO₂), particulate matter (PM), and Sulphur Dioxide (SO₂).

Quarantine during COVID-19 changed the air quality in the Kingdom of Saudi Arabia between 2019-2020, enabling researchers to study possible solutions to toxic emissions, Ex, Sulfur Dioxide was decreasing by controlling industries, traffic, and human activities, which correlated with lockdown and atmospheric pollution.

The percentage changes in concentration of SO₂ (44%) which is considered a high change in Jeddah city, from (19.44±2.12) to (7.53± 1.74) µg\m⁻³. unlike Mecca, which was at the top before and during lockdown, there was no significant decline. (Aljahdali et al., 2021)

In this study, we used the Google Earth Engine platform by JavaScript programming language to monitor the concentration of Sulfur Dioxide over Rabigh city in the Makkah region between 2020 and 2021 to measure SO₂ emissions before and during COVID-19 and study the result after applying Sulfur Reduction Unite (SRU).

Google Earth Engine platform is a cloud-based geospatial analysis platform that enables users to visualize and analyze satellite images of our planet. Scientists and non-profits use Earth Engine for remote sensing research, predicting disease outbreaks, and natural resource management.

the Copernicus Sentinel-5P mission is to perform atmospheric measurements with high spatio-temporal resolution, to be used for air quality, ozone & UV radiation, and climate monitoring & forecasting.

It carries a single high-precision optical payload called the TROPOMI (Tropospheric Monitoring Instrument). (PROGRAMME of the EUROPEAN UNION., 2017)

Besides, the sources of SO₂ Industries in Rabigh city, like many industrial cities, can contribute to pollution through various processes and activities, here are some industries commonly associated with pollution and their potential impacts:(EUROPEAN COMMISSION Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques for Mineral Oil and Gas Refineries, 2003; Speight, 2017)

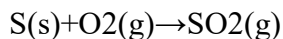
- Oil Refining and petrochemical manufacturing involve the combustion of fossil fuels and, the release of volatile organic compounds (VOCs) to generate electricity, SO₂, and NO₂. The most important emissions from oil refineries come from:16
- Refining furnaces.
- Activation of catalysts in FCC units.
- Sulfur dioxide emissions from power plants from diesel engines are considered primary pollutants.

These sources led to the creation of a significant problem known as Acid Rain, which is closely linked to SO₂. Acid rain is a general term that describes the precipitation of any form of moisture-containing acidic substances, whether in dry or wet form, with a pH level ranging from 4 to 5. (Acid Rain - Blog | Stuid Learning App, n.d.). To explain how Acid rain is formed, Coal and oil contain sulfur. When they ignite, they produce sulfur oxide chemicals. When they combine with water droplets in the troposphere, they can transform into sulfuric acid, which then can precipitate to the ground as acid rain. (Brown_et_al., n.d.). Additional climate perturbations may come from aerosols, formed when some compounds such as sulfur dioxide (SO₂) and dimethyl sulfide (CH₃-S-CH₃, or DMS) react in the troposphere to form H₂SO₄, which can lead to the formation of sulfate aerosols. These aerosols can absorb and scatter light, and, if appropriate in size, can also function as cloud condensation nuclei

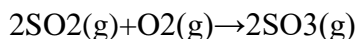
(CCN), changing the size distribution of cloud droplets and affecting cloud reflectivity. (Ghahremaninezhad et al., 2019)

Sulfur Dioxide Photochemistry:

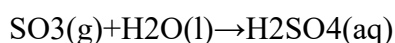
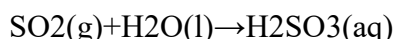
Sulfur dioxide (SO₂) is produced industrially from the combustion of sulfur-containing fossil fuels and smelting of sulfide ores (KATE M., 2015)



Sulfur dioxide (SO₂) is then oxidized by sunlight to form sulfur trioxide (SO₃)

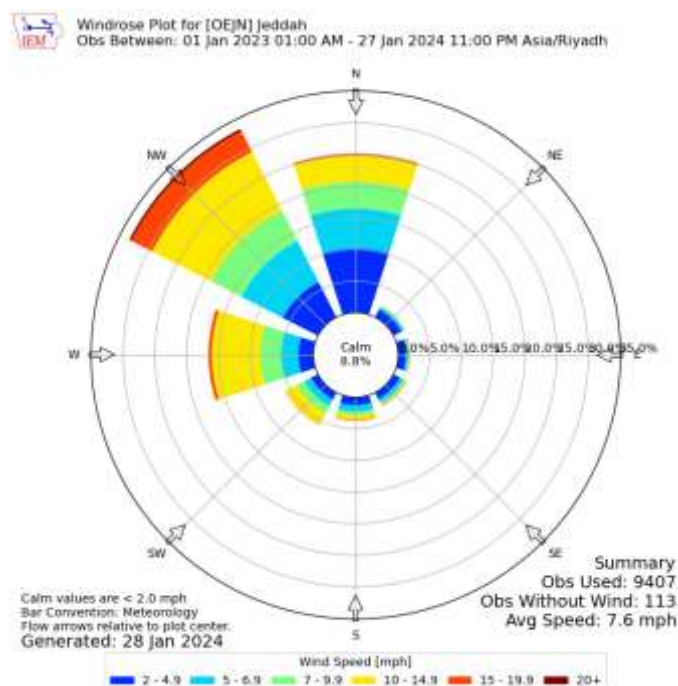


The oxides react with water to form acids



Wind Rose Diagram Wind Rose provides a detailed overview of the typical distribution of wind speed and direction at a specific location. Available in a round shape, the wind rose indicates the direction of wind coming from careful locations. In addition, provide instructions in the same format. Each circular band symbolizes a different frequency, starting from zero in the middle and increasing as it moves outward.(Learn How to Interpret a Wind Rose Diagram | Meteorology | Envitrans, n.d.; Wind Rose: The Beginners Guide - Perfect Services, n.d.

The photo(1) depicts the winds' path leading emissions to spread across Rabigh city in the northwest, where the majority of factories, Petro Rabigh, and power plants are situated:



Photo(4): A wind rose chart showing the prevailing wind directions in the Makkah region, home to the city of Rabigh situated along the Red Sea shoreline.(Iowa State University, n.d.)

METHODS

During this study, the level of SO₂ was gauged via GEE following the development of a JavaScript script, and the effects of the Wind Rose chart were analyzed over two years, with specific attention given to the Rabigh initiative for gas reduction.

Study Area

According to the Google Earth Engine platform in 2020, there was a significant decrease in sulfur dioxide levels in Saudi Arabia, particularly in cities along the Red Sea coast, with Rabigh being one of the cities that experienced a noticeable reduction in pollution compared with 2019. To illustrate, The Orange color represents the highest concentration of SO₂ (Figure.2)

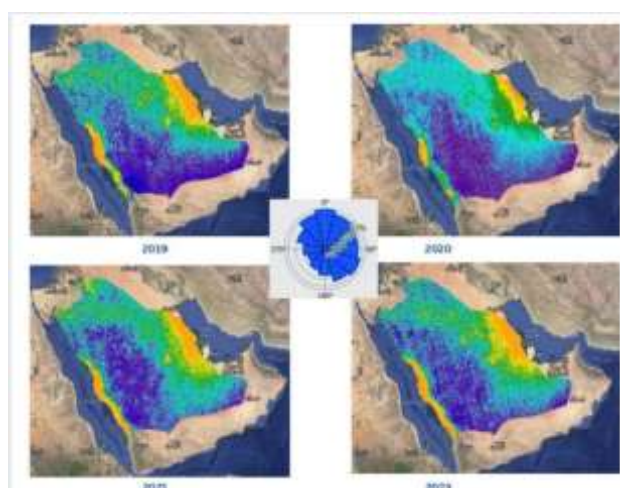


Figure.2: Sulfur Dioxide was determined by GEE and the density increases according to the following order:
Black → blue → purple → cyan → green → yellow → orange

Varieties Of Tech Employed to Decrease Sulfur Dioxide:

When sulfur dioxide reacts with nitrous oxide in the atmosphere, it produces acid rain, particulate air pollution, and regional haze. These circumstances pose risks to plant and animal life, inhibiting growth and causing negative health effects. Mixing both gases also leads to corroding metal, concrete, and other building materials, which weakens the structures and reduces their longevity. (Moon Fabricating Corporation, 2017)

To reduce sulfur dioxide, one of the methods used to remove sulfur, including *Desulphurization*, which is considered a good alternative in terms of cost compared to the high-value *Sulfur Recovery Unit*:

Desulphurization Of Flue Gas, Commonly Known As FGD.

FGD procedures are referred to as either 'wet' or 'dry'. Dry-type FGD systems use a reagent in dry powder form. Wet FGD systems use an alkaline slurry created by combining a dry reagent with

water. Despite the availability of two primary FGD designs, over three-quarters of power generation FGD systems utilize the wet method. As a Photo (3): (Flue Gas Desulfurization, n.d.; Inc, n.d.; Prasad, 2010)

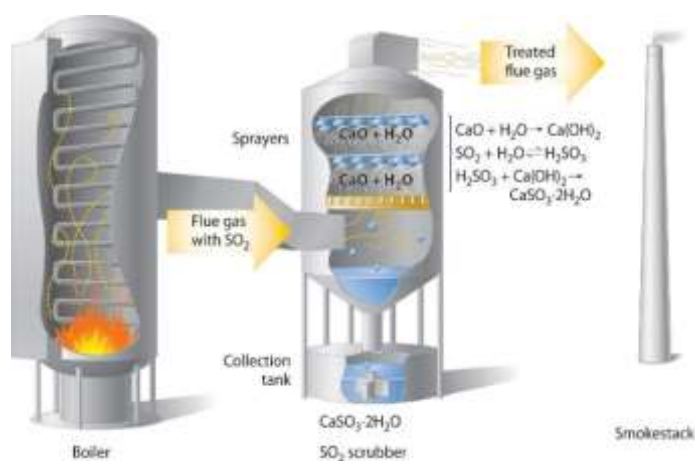


Photo (3): Desulphurization process

Sulphur Recovery Unite In Petro-Rabigh:

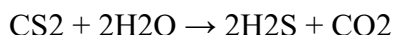
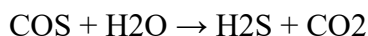
The SRU in a Petroleum Refinery removes H₂S from sour gases using the Claus Process, converting it into molten sulfur. This process eliminates 95-99.9% of hydrogen sulfide, burning the gas with oxygen and recovering molten sulfur, additionally, the unit has completed also the Clean Fuel project, start-up October 2020.

Both units will contribute to reducing the sulfur emissions into the atmosphere by recent environmental regulations. (COMMISSIONING AND START-UP OF SULPHUR RECOVERY UNIT IN SAUDI ARABIA | Kinetics Technology, n.d.)

The SRU, which will have an annual capacity of 106,000 tons, is an environmental requirement for the Rabigh project: (Petro Rabigh Awards SAR 563 Mln Clean Fuel, SRU Contract, 2016)

1. Sulfur steam generated in the heat reactor is collected from desulfurization equipment.
2. Gas-cooled to 315°C yields medium-pressure steam production.
3. Gas from waste heat boiler cooled to 130°C in 1st stage condenser, condensing sulfur stream for separation.
4. Gas from the primary condenser heated to 260-290°C by waste heat enters the primary reactor, producing sulfur. Cooled to 130°C in the second condenser, separating sulfur flow to pool.
5. Gas from the second condenser is heated by gas from the primary reactor and then flows to the second reactor. Gas-cooled in a third condenser and then separated into sulfur pool. The recovery ratio can reach 95%
6. The Tail Gas Treatment Unit (TGTU) aims to improve recovery rates and sulfur conversion ratios by adding hydrogenation deoxidization treatment to the tail gas from the Claus SRU unit, facilitating the hydrolysis of carbon disulfide, The reaction equation is shown below:





7. Process gas cooled with water in the heat exchanger, goes to the absorber where H₂S is absorbed by an amine and sent to the pipeline.

8. Absorber gas contains minor H₂S (usually lower than 200 ppmv) and then, transformed into SO₂ before being emitted, (figure 4.) illustrates the process SRU:

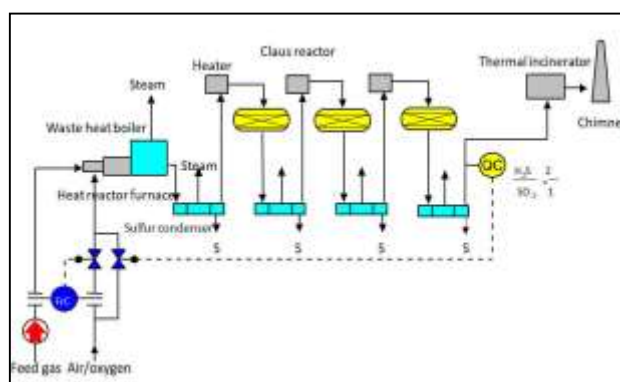


Figure 4. The industry of sulfur Recovery Units that complement oil refinery equipment is gaining prominence in the new century.(Ruichang (Luoyang Ruichang Environmental Engineering Co., n.d.)

DISCUSSION

Saudi Arabia is the fourth largest producer of SO_x emissions. Despite significant reductions in 2017 and 2018, emissions in Saudi Arabia have remained relatively stable, with a slight uptick seen in 2019.

The emissions recorded in the dataset come exclusively from the burning of oil and gas. Makkah, a province with a high population density, contains significant concentrations of SO_x emissions, with major sources found in Rabigh, Shaiba, and Jeddah. Oil power plants and oil refining facilities in these three areas were responsible for 62% of Saudi Arabia's overall sulfur oxide emissions in the year 2019, additionally, in 2020 COVID-19 led to a decrease in SO₂ in KSA by approximately -24%. Compared with previous years. (Dahiya et al., 2020)

Area Analysis:

A variety of air pollution sources located at a distance from Jeddah can impact and add to the city's air quality. An example is the city of Rabigh, located about 150 km north of

Jeddah has many pollution sources including the Petro-Rabigh refinery, desalination plant, power plant, cement company, and plastic company. The air quality and level of air pollution in Rabigh are impacted by these sources due to the release of gases which greatly add to the atmospheric pollution in the area. In addition, this study examined Rabigh (22°47'57.37"N, 39°02'00.83"E) from 2021 to 2022 was obtained from the Google Earth Engine (GEE) platform by JavaScript programming language. (Mohammed Othman et al., 2021)

At the same time, study the wind rose diagram in which the wind speed was evident (figure 5.), Strong winds coming from the northwest, which led to the spread of sulfur dioxide over Rabigh to the city of Jeddah, to clarify more, the concentration of sulfur dioxide increases from black to red like the 2021 year

Rabigh city uses Sulfur Recovery Unit Guaranteed Sulphur content in Naphtha < 10 ppmwt with CAPACITY: CFU 17,000 b/d. (Technology to Reduce Sulphur Content in Petroleum Products Maire Tecnimont Experience, n.d.)

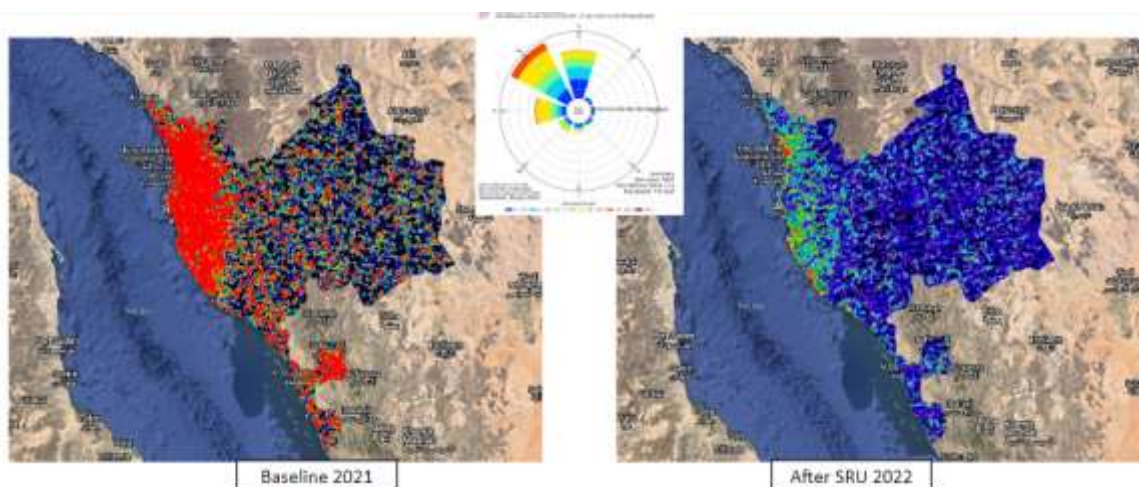
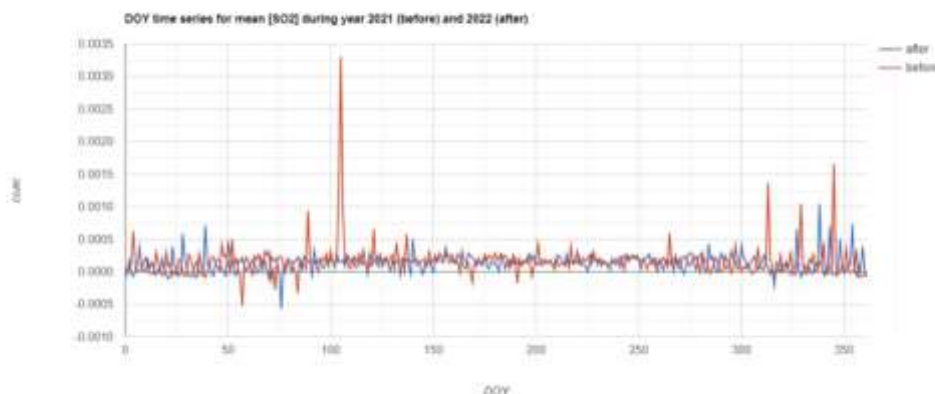


Figure 5. Effects of tide-surge interaction by comparison of TWL and SH for synthetic and observed typhoons.

Results

Data analysis

A line (Chart 6.) showing the comparison of two different sets of data across time, with the x-axis indicating the day of the year (DOY) and the y-axis indicating the sulfur dioxide (SO₂) concentration in Molecular per meter square (Mol/m²). The *after* data for average SO₂ levels in 2 years (2021-2022) is shown by the blue line, while the *before* scenario for the same year is represented by the red line.



(Chart 6) the concentration of SO₂ in Rabigh City before (2021) and after (2022)

Information from Google Earth Engine indicated that red peaks released a higher amount of pollutants compared to blue peaks; Rabigh City implemented Sulfur Recovery Units in 2021 to reduce SO₂ levels by the year 2022. The red peaks have a concentration of SO₂ emissions at 0.0030 Mol\m², which is higher than the blue peaks not more than 0.0010 Mol\m². Furthermore, the Sulfur Recovery Unit effectively reduces harmful gases emitted by industries and cities surrounding the Makkah region, safeguarding human health and the environment.

In addition, A study was conducted on SO₂ levels in the Makkah region before and during the COVID-19 outbreak. Before the pandemic, the Makkah region had SO₂ levels ranging from 3.5 to 10 µg/m³. The information was computed by taking the average of data collected from all six Air Quality Monitoring Stations (AQMS) spread out across the districts of Makkah, for the period leading up to the outbreak of COVID-19, from January 1 to March 10, 2020.

During the COVID-19 lockdown from March 11 to August 31, 2020, the SO₂ levels varied from 3.0 to 6.6 µg/m³. (Morsy et al., 2021).

In Conclusion, the sulfur recovery unit successfully decreased contaminants in a significant industrial city in Saudi Arabia, with the unit recuperating approximately 98% of sulfur between 2020 and 2021. (National Energy Technology Laboratory., n.d.) Furthermore, in March 2020, amidst the COVID-19 lockdown, there was a positive outcome in decreasing sulfur dioxide emissions while still upholding production levels. Throughout the lockdown, the GEE engine indicated that the gas levels above Rabigh city remained largely unchanged in industrial zones, but decreased in areas with heavy transportation traffic.

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EVALUATING THE PERFORMANCE OF A FULL-SCALE TRICKLING FILTER FOR MUNICIPAL SEWAGE TREATMENT IN ARID REGIONS: PREDICTING FECAL COLIFORM REDUCTION USING A MULTIPLE LINEAR REGRESSION MODEL

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Abstract

In response to water scarcity, Morocco faces the challenge of using treated wastewater for irrigation purposes. This study evaluates the efficiency of a full-scale trickling filter (TF) system in Imintanout, Morocco. The system consists of three septic tanks, two TFs, and secondary decanters. Over a 5-year period, the system showed a significant reduction ($p < 0.05$) in pollutants: 98% of TSS, 94% of BOD₅, 98% of COD, 41% of TP₄, and 88% of NH⁺. A multiple linear regression (MLR) model successfully predicted the removal of fecal coliform (FC) by the TF, and a reduction of 2.88 log units was achieved. High \cos^2 values indicated the importance of hydraulic loading rate (HLR), BOD₅, and FC, which were particularly affected by seasonal variations. Positive correlations between FC and TSS in certain periods highlight the seasonal variability in the composition of urban wastewater, which is effectively captured by the MLR model ($R^2 = 0.77$). Although the treated water complied with Moroccan discharge standards, its high nitrate (140 mg L⁻¹) and FC (4.32 log units) levels made it unsuitable for reuse in agricultural and landscape irrigation, as they exceeded safety

limits. This work highlights the importance of optimizing treatment systems to produce high quality reclaimed water, which is essential to meet the challenges of water scarcity

Keywords: Trickling filter; Wastewater treatment; Fecal coliforms removal; Linear regression model; Landscape

1. Introduction

Water resources have been declining in recent decades due to increasingly challenging environmental conditions. Arid and semi-arid regions, characterized by erratic rainfall patterns, frequent droughts, and other environmental stressors, have experienced an increase in water demand. This increase is particularly noteworthy given the seemingly anomalous phenomenon of urban irrigation in an area known for its arid expanses. At the same time, water stress has been exacerbated by the expansion of agricultural and industrial efforts to meet the demands of a growing world population [1]. In order to further improve the quality of life in the city, more water resources need to be made available for the irrigation of green spaces. Municipal wastewater can be an attractive alternative source of irrigation for cities that is less costly than pumping groundwater. The recovery and reuse of wastewater is usually described in terms of standards published or proposed by regional authorities or international organizations. To meet these standards, wastewater must be treated before it can be used for irrigation. Treating wastewater has also helped make cities in the developing world safer and more resilient. Through physical, chemical, or biological processes, wastewater treatment plants concentrate the pollutants in wastewater in the form of residues called sludge that can be used in agriculture. They also discharge treated water that meets specific standards and can be reused for irrigation and industrial purposes. Treatment processes include trickling filters, natural/aerated lagoons, biological discs, activated sludge, and multi-soil-layering systems [2- 3].

For wastewater managers, prediction can be a useful approach. It is used to understand the relationships between input and output variables and to predict a given output. Multiple linear regression (MLR) has many advantages, including mathematical simplicity, the ability to estimate input variable coefficients, and the ability to determine how they affect output variable variation [4]. Therefore, by using the MLR model to predict the coliform content in the output of the TF system, we can not only monitor the performance of the TF system, but also address the complex relationships between multiple variables within the TF system. This approach can improve the overall treatment efficiency of the system. It will also allow us to predict the coliform content of the TF effluent, which can potentially be reused for agricultural irrigation purposes. The city of Imintanout (Morocco) suffers from water scarcity. This is due to its location in a desert environment with an arid climate. This has led the authorities to focus on wastewater treatment, as it offers the double benefit of protecting groundwater resources and creating a new source of water, i.e. treated wastewater that can be reused in agriculture.

The objectives of this work are to: 1) evaluate the treatment efficiency and behavior of a full-scale TF plant in removing organic matter, nutrients, and fecal bacteria; 2) investigate the effect of seasonality on TF performance in an arid climate using Principal Component Analysis (PCA); 3) predict the fecal coliform concentration in TF effluent using the Multiple Linear Regression (MLR) technique and identify the relevant factors that can more accurately predict fecal coliform output in the TF system.

Material and methods

Description of the hybrid trickling filter plant

The current wastewater treatment plant is in operation since 2018. It serves the municipality of Imintanout (Morocco) with a population of 31,000. It is composed of a preliminary treatment consisting of a coarse screen followed by a fine screen and then two corridor grit chambers. The primary treatment consists of three primary circular decanters with radial flow and sludge removal via a scraper bridge. The biological treatment consists of two circular trickling filters (TF) equipped with a rotary distributor. The full-scale TFs are identical in size (13 m x 2 m) and are filled with a random type of plastic media with a specific surface area of 90 m² and a void ratio of 95%. Two secondary circular and radial flow decanters have also been designed. The sludge is stabilized in three upper cylindrical digesters. These are coupled to a truncated conical lower section. The sludge is dewatered in twelve drying beds with a total surface area of 1100 m². The WWTP was continuously fed with 1720 m³/day of HLR. Figure 1 shows the layout of the WWTP.



Fig.1. Presentation of the full-scale trickling filter system at Imintanout city (Morocco)

2.2. Water sampling and analyses

Raw and treated effluents were collected from the experimental site in sterilized glass bottles every three months for five years. All samples were stored at 4°C for bacterial and physicochemical analysis. The WTW multi 340i/multiparameter set probe (WTW Büro-Weilheim, Germany) was used for in situ analysis. The chemical oxygen demand (COD) was measured by the dichromate open reflux method [13], while the biochemical oxygen demand (BOD₅) was analyzed by the Warburg method. The filtration method was used to quantify the total suspended solids (TSS) content, the indophenol technique was used to measure the NH₄⁺ concentration, and the cadmium-copper column [16] was used to determine the NO₃⁻ concentration. Potassium peroxodisulfate digestion was used to determine total phosphorus (TP) [6]. For bacterial analysis, lactose-2, 3, 5-

triphenyl tetrazolium chloride TTC (Panreac,

Spain) with Tergitol agar (HiMedia, India) was used to determine total coliforms (TC) at 37°C and fecal coliforms (FC) at 44 °C [7].

3. Results and discussion

3-1-Statistical analysis of seasonal effects on trickling filter plant efficiency

The two significant dimensions [Dim1 (68.5%) and Dim2 (13.2%)] accounted for 81.7% of the variation in pollutant removal. Seasons such as summer and spring had a positive effect on Dim 1 and were closely associated with each specific parameter: HLR, Temp, pH, BOD, COD, TP, and FC. However, a negligible relationship was found with Dim2. The PCA \cos^2 plot also shows the average difference between the spring and summer seasons in terms of the variability of the distribution of HLR, T, pH, BOD, COD, TP and FC.

It was shown that HLR, BOD₅, and FC all had high \cos^2 values ranging from 0.86 to 0.96, indicating that they are significant seasonal variables. The significant effects of the two seasons on HLR and the removal of BOD₅ and FC can be used to explain these data, indicating that HLR and the methods used to remove organic particles and bacterial indicators in TF systems are likely seasonal. The concentration of COD and FC showed a significant relationship. In the presence of organic matter, the fecal bacterial indicator grows significantly faster [9]. Furthermore, a significant effect of organic matter on the abundance of *E.coli* was observed by Bouteleux et al [11]. However, it may be difficult for FC bacteria to survive due to the high removal rate of organic matter in the TF system. In addition, Arora & Kazmi [13] showed how the warm season enhances the decomposition of organic matter by increasing the metabolic activity of bacterial cells. The TF system removed organic matter very well and did not clog during operation.

The structure and design of TF materials maintain high water permeability, which reduces the potential for clogging [13]. CW, sand filters and lagoons are other unconventional technologies with known seasonal effects on pollutant removal. Ouellet-Plamondon et al. [14] found that COD reduction in CW was slightly better in summer than in winter. Seasonality is known to play a significant role in the removal of coliforms and pathogens in wastewater treatment processes [8],[9]. Furthermore, FC bacteria was the variable most affected by spring and summer variations ($\cos^2 > 0.86$).

This result indicates that microbial degradation was the primary FC removal mechanism in the TF system. El Hamouri et al [15] found that high rate algal pond method resulted in higher coliform removal during summer in arid region. Higher temperatures in the CW system improve the removal of coliform indicator bacteria. TSS shows negative contributions to Dim 1 ($\cos^2 > 0.85$), but only a negligible relationship with Dim². There is a good correlation with the six individuals during fall and winter and summer (individual PCA). The reason for this finding was the highest TSS concentration ever recorded in municipal wastewater during this period.

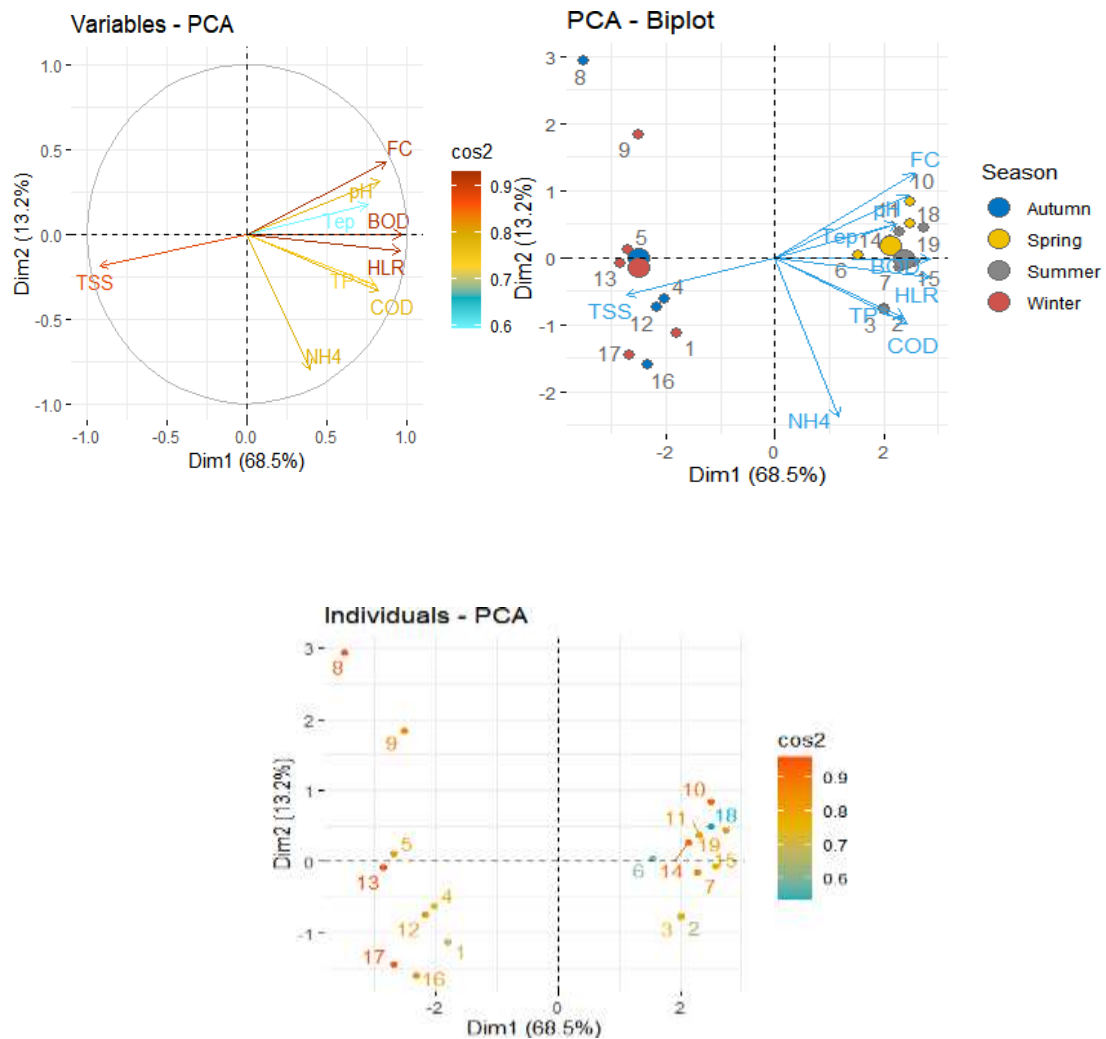


Fig.2. Effect of Seasonal Variations on TF Plant Removal Effectiveness: A Principal Component Analysis (PCA) Perspective. Variables-PCA illustrates the relationships between variables and the principal components; PCA-Biplot visualizes the relationships between variables and observations in the dataset across different seasons. Individuals-PCA displays the projection of individual data points onto the principal components to indicate similarities or differences among the observations.

3.2. Multiple linear regression prediction

Figure 3, shows the regression analysis of the MLR model, which further supports its effectiveness in predicting FC removal. As a result, the proposed MLR model can be used as a valuable tool to evaluate the behavior of the TF system in the face of FC contamination. In addition, the MLR model has successfully predicted the FC concentration at the outlet of the system. This provides valuable insights for future TF efficiency management. Therefore

MLR serves as a simple and reliable model to interpret the effect of input variables on the output

variable through its coefficients.

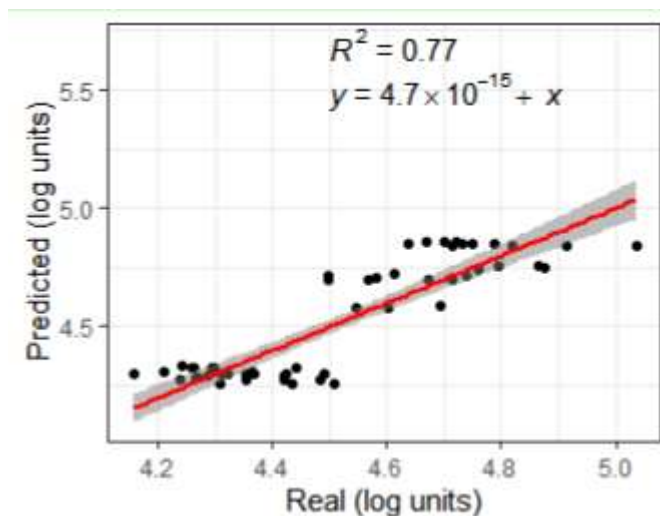


Fig.3. Performance of MLR model in prediction of FC level based on comparison of predicted and observed removal of FC in TF system (Period covered 5 years).

3.3. Water quality and environmental implications

Results of this study showed that a hybrid TF plant effectively removes organics, nutrients, and fecal coliforms from municipal wastewater. In addition, during the five-year monitoring period, no obvious problems (such as clogging, odor, insects, etc.) were observed. Table 2 shows that post-treatment pH, EC and TSS values are in the high range of limits allowed for direct discharge in Morocco [10].

Table 1. Level recommended for treated wastewater reuse in irrigation

Variable	Unit	Influent	Effluent	Admissible limits for direct discharge [43]	Admissible limits for wastewater Reuse [44]
pH	unit	7.65 ± 0.33	8 ± 0.37	-	6.5 – 8.4
EC	mS/cm	2219 ± 220	1939 ± 190	-	12000
TSS	mg L ⁻¹	790 ± 30.97	12.02 ± 1.75	150	100
BOD ₅	mg L ⁻¹	650 ± 13.05	10.50 ± 0.50	120	-
DCO	mg L ⁻¹	1352 ± 56.77	75.04 ± 13.70	250	-
NO ₃ -N	mg L ⁻¹	0.08 ± 0.01	140.03 ± 12.09	-	30
FC	log CFU/100mL	6.57 ± 0.70	4.32 ± 0.60	-	3

Conclusion

This study focuses on investigating a large-scale hybrid trickling filter (TF) technology for treating urban wastewater in an arid climate. Significant removal rates ($p < 0.05$) were achieved for TSS, BOD₅, COD, TP, and NH₄⁺, indicating the effectiveness of the hybrid TF system. Seasonal variations had a significant impact on the performance of the TF, especially in the summer and spring, with variables such as HLR, BOD₅, and fecal coliforms showing high \cos^2 values. The positive correlation between the TSS concentration and the seasonality implies that the composition of the wastewater varies throughout the year. Key parameters were identified as significant contributors to the removal of fecal coliform (FC) in the TF system, including DO, NO₃⁻, and TSS. The developed Multiple Linear Regression (MLR) model, with an R² value of 0.77, shows promise in predicting FC removal in similar wastewater treatment plants, although further validation in different contexts is needed to ensure its reliability. Despite compliance with Moroccan standards for direct discharge, treated municipal wastewater does not meet safe reuse criteria for irrigation due to high nitrate levels above the allowable limit of 30 mg/L and fecal coliform levels above the allowable limit of 3 log units. This makes upgrading the wastewater treatment plant (WWTP) a challenge for the Imintanout community. Additional treatment measures are essential in order to achieve a water quality that meets Moroccan standards for the irrigation of agricultural crops and landscaping.

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ANALYZING THE INFLUENCE OF MARBLE WASTE AND FLY ASH SUBSTITUTION FOR SAND ON CONCRETE'S COMPRESSIVE STRENGTH AND WORKABILITY

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Introduction

Concrete is a vital structural component, second only to water in usage, with annual production of about 5.3 billion cubic meters, expected to rise to 18 billion tons by 2050. Made from water, aggregates, and cement. Concrete production accounts for 8% of global CO₂ emissions, with Portland cement as a major contributor. To mitigate this, eco-friendly alternatives using industrial and agricultural waste are suggested.

Research Relevance

The primary objectives of this study are to minimize environmental degradation and reduce reliance on natural resources. To accomplish these goals, we thoroughly examined the properties of concrete made, in part, by substituting fly ash and marble dust for natural sand in the fine aggregate mix. For the study, three series of mixes were made. Marble dust was used in place of natural sand in the first series (S1) at rates ranging from 10% to 50%, increasing by 10% at a time. Fly ash was used in place of natural sand at the same incremental rates in the second series (S2). A third series (S3) was prepared using a combination of marble waste and fly ash at varying substitution rates in order to assess the performance of waste marble in place of sand and that of replacing sand with fly ash. These modifications are applied to concrete samples, and their compressive strength and workability are assessed. Through a detailed analysis of the effects of these modifications on the properties and functionality of concrete, we hope to evaluate the viability and ecological advantages of this different strategy.

Experimental study

Characterization of materials

Portland cement CPJ 45 from Holcim was used as the binder, meeting Moroccan specifications NM10.1.004. Water supplied by RADEEO was utilized. Natural sand from the Oujda region, with a maximum size of 4.75 mm, was employed. Crushed coarse stone aggregates G1 (10 mm) and G2 (20 mm) were used, along with marble dust as coarse aggregate. F-class Fly Ash from the Jerada

thermal power plant was also included. Tables 1 and 2, along with Figure 1, provide detailed properties and analyses of the materials used.

Table 1. Physical characteristics of Cement, Fly Ash, Sand, Coarse aggregate G1, G2, and Waste Marble aggregate (WMA).

Property	Cement	Fly Ash	Sand	G1	G2	WMA
Specific Gravity	3.15	2.20	2.68	2.70	2.72	2.73
Water absorption %		3.01	2.50	1.48	1.50	0.5
Consistency (%)	29					
Fineness modulus		0.96	2.85	6,62	6,82	7,68
Initial setting time (min)	180					
Final setting time (min)	210					
Fineness Blaine (cm ² /gm)	3100	3360				
		1.				

Table 2. Chemical constitution of cement, Fly Ash and sand.

Constituent (%)	Cement (%) by mass	Fly Ash (%) by mass	Sand (%) by mass
CaO	60.06	1.18	5.58
SiO ₂	20.90	55.2	77.40
Fe ₂ O ₃	3.90	11.2	2.66
AL ₂ O ₃	5.85	28.3	8.18
MgO	1.85	0.68	0.77
K ₂ O	2.14	1.45	0.25
TiO ₂	0.32	1.5	0.005
SO ₃	2.35	0.44	0.018
LOI	21.84	1.06

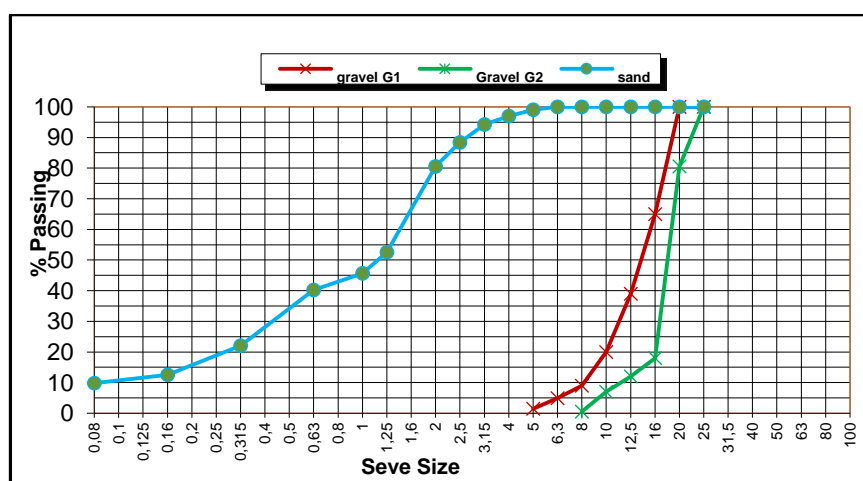


Fig. 1. Distribution of sand, gravel G1, and gravel G2 particle sizes

To assess the impact of substituting waste marble powder and Fly Ash for a part of natural sand on concrete performance, a 0.55 water-to-cement ratio was used to create 15 mixtures for every test specimen. In the first series (S1), natural sand was substituted with marble dust at rates ranging from 10% to 50%. In the second series (S2), natural sand was substituted with fly ash at the same incremental rates. In the third series (S3), the sand was partially replaced by a mixture of marble waste and fly ash. The mixture ratios of Fly Ash, Waste Marble Powder, sand, coarse aggregates, and Cement are listed in Table 3. The symbol SFS denotes Fly Ash utilized as a natural sand alternative, while SM represents Waste Marble Powder used in place of natural sand. For instance, SFS20-SM10 indicates a mixture where Fly Ash replaces 20% of the natural sand and Waste Marble Powder replaces another 10%. The Dreux-Gorisse model was applied to carry out the concrete design.

Table -3. Mixture proportions with w/c=0,55.

Mix	Water (Kg/m ³)	Cement (Kg/m ³)	G1 (Kg/m ³)	G2 (Kg/m ³)	FA (Kg/m ³)	Fly Ash (Kg/m ³)	WMP (Kg/m ³)
SM0-SFS0	192	350	320	815	763	0	0
SM-10	192	350	320	815	687	0	76
SM-20	192	350	320	815	610	0	153
SM-30	192	350	320	815	534	0	229
SM-40	192	350	320	815	458	0	305
SM-50	192	350	320	815	381	0	382
SFS-10	192	350	320	815	687	76	0
SFS-20	192	350	320	815	610	153	0
SFS-30	192	350	320	815	534	229	0
SFS-40	192	350	320	815	458	305	0
SFS-50	192	350	320	815	381	382	0
SM10-SFS10	192	350	320	815	611	76	76
SM10-SFS20	192	350	320	815	534	76	153

Test Parameters

Test for hardened concrete

Compressive strength is crucial for assessing the structural capacity of concrete in buildings. To find out the concrete's compressive strength, concrete cubes measuring 150 mm on each side are cast. According to NF EN 12390-3, compressive strength is measured at curing ages of days 7, 14, 28, and 56. The samples were cured under 100% relative humidity and a constant ambient temperature of $27 \pm 2^\circ\text{C}$ with water.

Test for fresh concrete

The effect of partially substituting Waste marble powder and Fly Ash for Natural sand on the regularity of freshly mixed concrete mixes was studied using the slump cone test in compliance with NF EN 12350-2. The slump cone had a standard size, measuring 300 mm in height, 200 mm in bottom diameter, and 100 mm in top diameter. Workability was assessed by conducting slump tests on all the mixtures and measuring the slump values for various concrete blends.



Fig. 2. Compressive Universal Testing Machine



Fig.3.Slump Testing

Results and conversational analysis

Marble powder's impact on the concrete's workability

In this study, the workability of the mixes in the three series S1, S2, and S3 was evaluated was assessed. Table 4, displays the replacement levels of mixtures and their corresponding slump values, which varied between 49 and 75 mm. It was noted that, in the three series, when waste marble powder and fly ash are used in place of natural sand, the slump decreases as stated in figures 4, 5, and 6. The results show that incorporating of waste marble powder at 50% of natural sand makes the mixes less workable than the control concrete. The decrease in workability with the addition of waste marble powder can be attributed to the angular shape of the marble waste aggregates and the increased surface area to be wetted, leading to reduced workability.

Table 4 : Slump value Test

Mix designation	Slump(mm)	Mix designation	Slump(mm)
SM0FS0	75	SM10-FS10	63
SM10	68	SM10-SFS20	57
SM20	64	SM20-SFS10	58
SM30	60	SM20-FS20	53
SM40	53	SM20-FS30	51
SM50	49	SM30-FS20	50
SFS10	69	SM10-FS40	51
SFS20	63	SM40-FS10	49
SFS30	60		
SFS40	56		
SFS50	54		

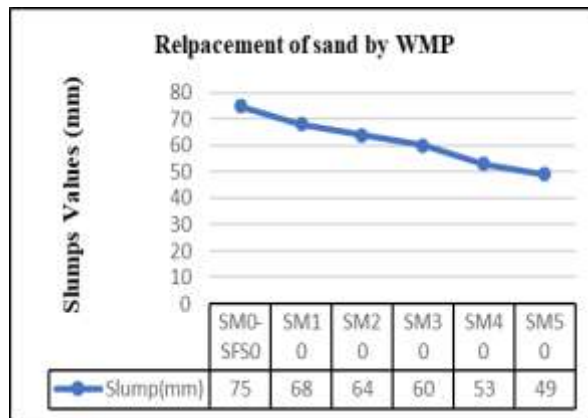


Fig. 4. Workability of WMP concrete

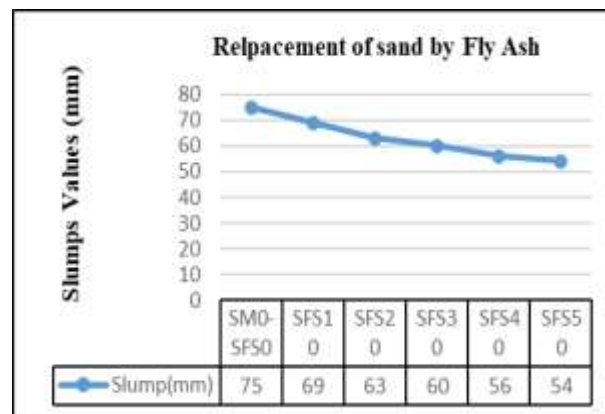


Fig.5. Workability of Fly Ash Concrete

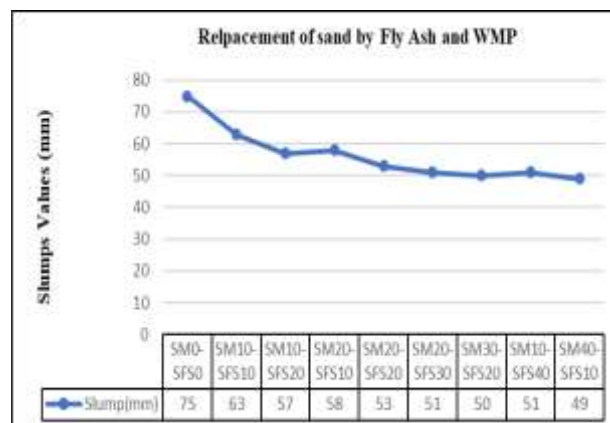


Fig.6. Workability of Fly Ash and WMP Concrete

Marble powder's impact on the compressive strength

Tests of compressive strength were carried out on concrete samples. During the process, the specimens underwent water curing. Before analysing each concrete specimen at days 7, 14, 28, and 56, samples were given a full day to dry. Three specimens were used to obtain the average result.

Utilizing the universal testing machine (UTM), compressive strength results were acquired. The compressive strengths of the specimens are presented in Table 5. In series (S1), natural sand was changed with Waste Marble Powder at percentages ranging from 10% to 50%, increasing incrementally by 10%. In series (S2), natural sand was replaced with Fly Ash at similar incremental percentages. In series (S3), natural sand was replaced by a mixture of marble waste and fly ash. Here, (S1), (S2), and (S3) refer to the series of mixes mentioned above. It is observed that in the three series of mixes, and at all ages, the compressive strength increases compared to the control mix, with a peak reached at 20% replacement of Waste marble Powder and 30% replacement of Fly Ash. It should also be noted in Figures 7, 8, and 9, that the compressive strength shows an increase of 49.94%, 49.15%, 49.53%, and 53.08% compared to the control mix at days 7,14,28 and56, respectively.

Given that the SM20-SFS30 sample yielded the greatest level of compressive strength, substituting 20% of natural sand with waste marble powder and 30% of natural sand with Fly Ash represents a practical and effective partial solution for replacing natural cementitious materials with marble by-products.

Table 5: Compressive test value

% Replacement	Day 7	Day 14	Day 28	Day 56
SM0SFS0	17,60	21,32	27,94	28,05
SM10	19,32	23,40	30,27	30,84
SM20	20,62	24,03	32,53	32,98
SM30	19,38	26,62	33,47	34,28
SM40	19,65	26,68	33,86	35,03
SM50	18,60	24,27	30,81	31,98
SFS10	19,41	23,52	30,86	31,17
SFS20	20,50	24,51	32,58	33,54
SFS30	22,7	27,13	34,38	35,71
SFS40	24,04	28,01	35,78	37,35
SFS50	22,77	26,04	31,84	32,52
SM10-SFS10	21,54	25,80	33,38	34,61
SM10-SFS20	22,49	26,91	34,78	35,84
SM20-SFS10	22,73	27,05	35,79	37,92
SM20-SFS20	24,01	28,62	37,86	39,28
SM20-SFS30	26,58	31,80	41,78	42,94
SM30-SFS20	22,57	26,83	35,44	36,52
SM10-SFS40	26,39	31,35	41,16	42,58
SM40-SFS10	21,67	25,67	34,06	34,62

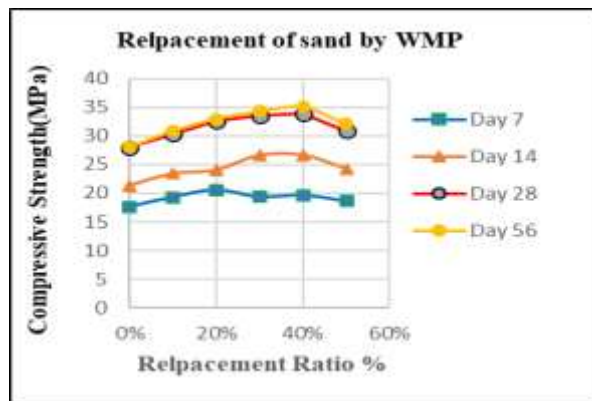


Fig.7. Compressive Strengths of WMP Concrete

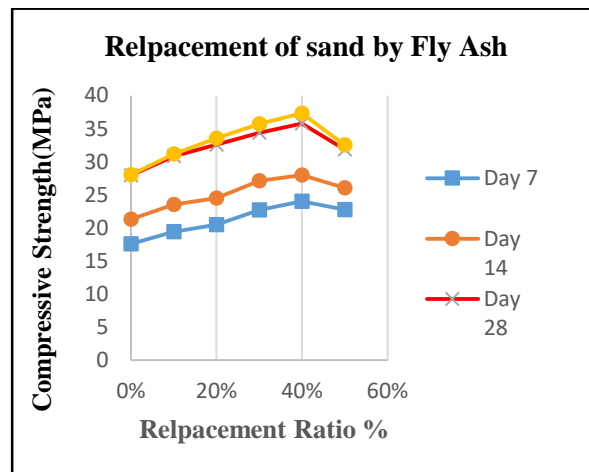


Fig.8. Compressive Strengths of Fly Ash Concrete

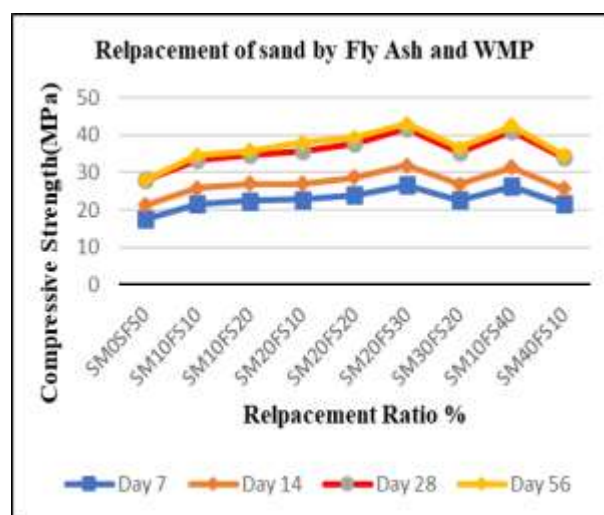


Fig.9. Compressive Strengths of Fly Ash and WMP Concrete

Conclusion

An important vacuum in the current understanding of sustainable building materials has been identified by studies on the use of fly ash and leftover marble powder in place of natural sand in concrete. Prior research has looked at some sand alternatives; however, it hasn't sufficiently investigated the combined effects of fly ash and marble powder.

The purpose of this study was to assess how these substitute materials would affect the concrete's workability and compressive strength. The findings demonstrate that adding 20% marble powder and 30% fly ash in place of natural sand greatly increases the concrete's compressive strength. Significant gains are seen at all test ages, including 7, 14, 28, and 56 days. In comparison to the control mix, the increases in compressive strength were 49.94%, 49.15%, 49.53%, and 53.08%, in that order.

In terms of workability, as replacement levels increased, the slump values of the mixes containing waste marble powder and fly ash decreased, ranging from 49 to 75 mm. Specifically, the angular shape and increased surface area of the aggregates made a 50% replacement with marble powder less workable.

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**AGROINDUSTRIAL WASTE AS A SUBSTRATE FOR THE PRODUCTION OF
MICROBIAL ENZYMES AND A SOURCE OF FERMENTABLE SUGARS FOR THE
PRODUCTION OF BIOETHANOL**

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Abstract

Environmental issues and concerns about reducing ecological pollution have led to an increased demand for 'clean technology' in the chemical, energy, and food industries. This practice involves the use of alternative materials, lower energy use, and reduction of pollutants in industrial discharges, and is more economical due to lower costs. In this context, the potential of waste from agro-industry, forestry, and urban sources in bioprocesses has sparked optimism in the scientific community. These materials, when used as substrates for microbial cultivation, aim at the production of cellular proteins, organic acids, fungi, biologically important secondary metabolites, enzymes, prebiotic oligosaccharides, and as a source of fermentable sugars for the production of second-generation bioethanol. Agro-industrial wastes are valuable sources of lignocellulosic materials, the main constituent structure of plants and the main source of renewable organic material in the soil.

The research on enzymes involved in the degradation of lignocellulosic materials and the search for new species exhibiting higher enzyme production potential is of great biotechnological importance. Some agro-industrial wastes are commonly used for these purposes, such as fibrous residues of sugar cane, wheat bran, corn cob and straw, rice straw and husks, soybean bran, barley and coffee husks. Cellulases, xylases and ligninases are microbial enzymes with application potential in several biotechnological processes.

Recent research has been directed towards the potential use of enzymes for the degradation of lignocellulosic materials. The aim is to release fermentable sugars that can be converted into ethanol by fermentative microorganisms. Lignocellulosic residues such as rice straw, wheat bran, wheat straw, sawdust, rice husks, corn straw, and sugar cane residues are enzymatically saccharified for ethanol production. We will delve into the application of lignocellulosic waste as substrates for the growth of microorganisms capable of producing enzymes such as cellulases, hemicellulases, and ligninases, as well as sources of fermentable sugars, in the production of second-generation ethanol by enzymatic hydrolysis. Enzymatic saccharification (hydrolysis) of lignocellulosic biomass offers distinct advantages over chemical conversion, including the elimination of substrate loss due to chemical modifications, the use of moderate non-corrosive operational conditions, and better yield without generating secondary products. The saccharification of lignocellulosic material and the conversion of the sugar formed into ethanol may require the use of different strategies, carried out

simultaneously or sequentially. In all cases, the pretreatment step is of primary importance for increasing the enzymatic conversion efficiency.

Experimentally, in the laboratory, it has been tried to follow the progress of the controlled pretreatment of mixed cultures of malted barley and corn, and then the change of the sugar content in % depending on the fermentation time. Interestingly, the content of bioethanol obtained decreases with the increase of the contribution of corn in the mixture with malted barley. Ethanol potentials from selected raw materials (corn, rye, clover, grass, animal manure and whey) were measured and evaluated. All investigated substrates were suitable for energy production through yeast fermentation.

Keywords: bioethanol, agro-industrial waste, ecological pollution, bioprocesses, fermentable sugars, biodegradation

Introduction

Agroindustrial Waste as a Substrate for Microbial Enzymes

The growing concern for environmental sustainability and the need for alternative energy sources have led to an increased focus on the utilization of agroindustrial waste as a substrate for the production of microbial enzymes and bioethanol. Agroindustrial waste, which includes lignocellulosic materials such as agricultural residues and food processing byproducts, represents a vast and largely untapped resource for the production of valuable bioproducts. This paper aims to review the potential of agroindustrial waste as a substrate for the production of microbial enzymes and fermentable sugars for bioethanol production, highlighting the latest research and developments in this field.

Agroindustrial waste is a rich source of nutrients and carbon for microorganisms, making it an attractive substrate for the production of various enzymes. The lignocellulosic components of agroindustrial waste can be broken down by microbial enzymes, such as cellulases, hemicellulases, and ligninases, to release fermentable sugars. These enzymes have numerous applications in industries like food processing, biofuels, and textile manufacturing. Several studies have demonstrated the feasibility of using agroindustrial waste as a substrate for the production of enzymes by various microorganisms, including bacteria and fungi.

Pretreatment and Hydrolysis of Agroindustrial Waste

To effectively utilize agroindustrial waste for the production of fermentable sugars, pretreatment and hydrolysis are necessary. Pretreatment methods, such as physical, chemical, and biological treatments, aim to disrupt the recalcitrant structure of lignocellulosic materials, making them more accessible to enzymatic hydrolysis. Enzymatic hydrolysis, using cellulases and hemicellulases, then breaks down the cellulose and hemicellulose components into fermentable sugars, such as glucose and xylose. The choice of pretreatment and hydrolysis methods depends on the specific characteristics of the agroindustrial waste and the desired end products.

Bioethanol Production from Agroindustrial Waste

The fermentable sugars obtained from the hydrolysis of agroindustrial waste can be used as a substrate for the production of bioethanol. Microorganisms, particularly yeasts and bacteria, are

employed to ferment the sugars into ethanol. Several factors, such as the composition of the hydrolysate, the choice of microorganism, and the fermentation conditions, influence the efficiency of bioethanol production. Recent advancements in consolidated bioprocessing (CBP), which combines enzyme production, hydrolysis, and fermentation in a single step, have shown promising results in improving the overall efficiency and cost-effectiveness of bioethanol production from agroindustrial waste.

Case Studies and Examples

Corn stover: Corn stover, which includes the stalks, leaves, and cobs of corn plants, is another widely studied agroindustrial waste for bioethanol production. Studies have shown that pretreatment methods, such as ammonia fiber expansion (AFEX) and dilute acid pretreatment, can enhance the enzymatic digestibility of corn stover, leading to higher yields of fermentable sugars and bioethanol.

Wheat straw: Wheat straw, a byproduct of wheat production, has been investigated as a substrate for the production of xylanases by bacteria and the subsequent conversion of the hydrolysate into bioethanol by genetically engineered microorganisms capable of fermenting both glucose and xylose.

So, the utilization of agroindustrial waste as a substrate for the production of microbial enzymes and bioethanol presents a promising approach for sustainable waste management and the production of valuable bioproducts. By optimizing pretreatment and hydrolysis methods, researchers can enhance the efficiency of converting lignocellulosic materials into fermentable sugars. The development of robust microorganisms capable of fermenting a wide range of sugars and the implementation of consolidated bioprocessing strategies can further improve the overall process economics. As research in this field continues to advance, the integration of agroindustrial waste utilization into the bioeconomy will become increasingly viable, contributing to a more sustainable future.

The utilization of agroindustrial waste for bioethanol production can also generate valuable co-products, such as animal feed, fertilizers, and electricity from process residues. These co-products can contribute to the overall revenue stream and improve the economic viability of the bioethanol production process.

Challenges and Limitations

While the use of agroindustrial waste can reduce the cost of bioethanol production, there are still challenges to be addressed. The heterogeneous nature and potential variability in the composition of agroindustrial waste may require more complex pretreatment and processing methods, which can increase costs. Additionally, the availability and consistency of waste supply may be limited in some regions, affecting the scale and reliability of bioethanol production. In conclusion, the use of agroindustrial waste as a feedstock for bioethanol production has the potential to significantly reduce the overall cost of production compared to using food crops or dedicated energy crops. By leveraging existing waste streams, minimizing transportation costs, and generating valuable co-products, the economic viability of bioethanol production can be enhanced. However, challenges related to feedstock variability and supply must be addressed to fully realize the cost benefits of utilizing agroindustrial waste.

Corn Stover

Corn stover, which includes the leaves, stalks, and cobs left after corn harvesting, is another significant agroindustrial waste in Albania. It is a lignocellulosic material that can be pretreated to enhance the accessibility of sugars. Enzymatic hydrolysis can convert the cellulose and hemicellulose in corn stover into fermentable sugars, making it suitable for bioethanol production.

Wheat Straw

Wheat straw is a common agricultural residue that can be effectively utilized for producing fermentable sugars. Similar to corn stover, wheat straw is rich in cellulose and hemicellulose. Pretreatment methods, such as alkaline or acid treatment, can improve sugar yields during hydrolysis, allowing for efficient fermentation into bioethanol.

So, The agroindustrial wastes in Albania, such as olive oil byproducts, sugar beet pulp, grape pomace, corn stover, and wheat straw, present excellent opportunities for producing fermentable sugars. By optimizing extraction and fermentation processes, these wastes can be converted into valuable bioethanol, contributing to sustainable energy solutions and reducing environmental waste.

Albania can utilize its agro-industrial waste to reduce environmental impact in several ways:

Developing Biomaterials

Agricultural wastes can serve as raw materials for producing biodegradable and eco-friendly biomaterials such as bionanofilms, bioaerogels, hydrogels, and nanocomposites. These materials have applications in packaging, construction, and tissue engineering, reducing the need for non-biodegradable petroleum-based alternatives. By implementing these strategies, Albania can transform its agro-industrial waste into valuable resources, reduce environmental pollution, and contribute to a more sustainable and circular bioeconomy. Adopting eco-friendly waste management practices and investing in innovative technologies can help Albania achieve its sustainability goals while creating new economic opportunities in the agricultural sector.

Producing Bioethanol from Waste

Albania's abundant agro-industrial wastes, such as olive oil byproducts, grape pomace, cereal straws, and sugar beet pulp, can be converted into fermentable sugars through pretreatment and enzymatic hydrolysis. These sugars can then be fermented by microorganisms to produce bioethanol, a renewable transportation fuel that reduces greenhouse gas emissions compared to fossil fuels.

Extracting Bioactive Compounds

Many agro-industrial wastes contain valuable bioactive compounds like polyphenols, flavonoids, and antioxidants. Emerging technologies such as supercritical fluid extraction (SFE), microwave-assisted extraction (MAE), and ultrasound-assisted extraction (UAE) can efficiently extract these compounds from waste streams. The extracted compounds have applications in pharmaceuticals, cosmetics, and functional foods, reducing the need for synthetic alternatives.

Producing Biofertilizers and Soil Amendments

Composting and anaerobic digestion can convert organic agricultural wastes into nutrient-rich biofertilizers and soil amendments. These products improve soil health, increase crop yields, and reduce the need for synthetic fertilizers. Proper waste treatment also prevents the release of harmful substances like pesticides and animal manure into the environment.

Generating Renewable Energy

Agro-industrial wastes can be used as feedstock for biogas production through anaerobic digestion. The biogas can be used for heat and electricity generation, replacing fossil fuels. Waste-to-energy technologies like pyrolysis and gasification can also convert agricultural residues into syngas and bio-oil, which can be further refined into biofuels and biochemicals.

How does the use of agroindustrial waste impact the cost of bioethanol production

The use of agroindustrial waste as a feedstock for bioethanol production can significantly reduce the overall cost compared to using food crops or lignocellulosic biomass. Here's how agroindustrial waste impacts the cost of bioethanol:

Reduced Feedstock Costs

Agroindustrial waste, such as sugarcane bagasse, corn stover, and wheat straw, is often considered a waste product with minimal economic value. By utilizing these materials as feedstock for bioethanol production, the cost of raw materials is greatly reduced or even eliminated, as the waste is obtained at little to no cost.

Potential for On-Site Production

Many agroindustrial facilities, such as sugar mills and ethanol plants, generate significant amounts of waste biomass on-site. By integrating bioethanol production facilities within these existing plants, transportation costs and infrastructure requirements are minimized, further reducing the overall cost of production.

Improved Process Economics

Studies have shown that the use of agroindustrial waste can lead to significant cost savings in bioethanol production. For example, bioethanol production from oil palm fronds (OPF) was estimated to cost \$0.52/L, which is lower than the cost of sugarcane-based bioethanol and higher than lignocellulosic bioethanol from dedicated energy crops.

Potential for Co-Products

The utilization of agroindustrial waste for bioethanol production can also generate valuable co-products, such as animal feed, fertilizers, and electricity from process residues. These co-products can contribute to the overall revenue stream and improve the economic viability of the bioethanol production process.

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Albania can utilize its agro-industrial waste to reduce environmental impact in several ways:

Some of the reasons for using renewable energy sources, particularly bioethanol, are:

- A future-oriented towards sustainable energy supply.
- Conservation of resources and protection of the environment. Conservation of resources and protection of the environment are the essential reasons why we need a sustainable and ecologically friendly energy supply.
- Unlimited energy from renewable sources

A stable energy supply can only be ensured through renewable energy production technology.

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Materials and Methods

Preparation of the mass. In this experimental work, we started with the preparation of the mass or porridge which will then be subjected to fermentation for bioethanol production. A sample of corn of a special crop for ethanol production was taken (remember that not every corn crop is suitable for ethanol production), i.e. corn flour, and it was subjected to the saccharification process for enzyme activation and starch hydrolysis for sugar production. fermentable. The saccharification procedure for corn is carried out following this chart. In corn saccharification, we have the activation of α -amylases which act at temperatures and break the α (1-4) glucosidic bonds of starch and give oligosaccharides and dextrans. It is activated at temperatures of 60 - 70 0C. After hydrolysis with α -amylase, gluco-amylases are put to work. Gluco - amylases remove a glucose from dextrin. Gluco-amylases work at a temperature of 58-60 0C.

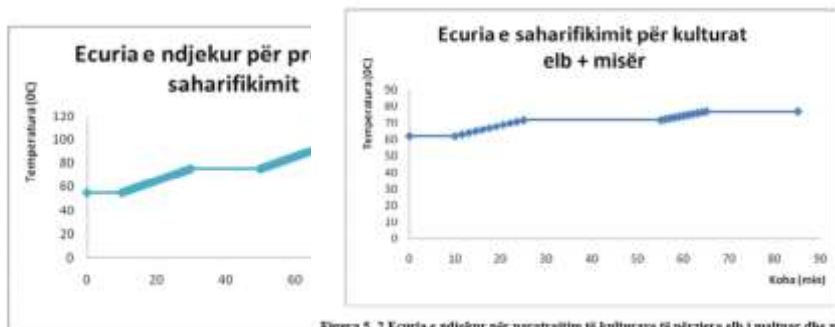


Figura 5. 1 Grafiku i ndjekur për paratrajtimin e misrit

Figura 5. 2 Ecuria e ndjekur për paratrajtim të kulturave të përziera elb i maltuar dhe misër.

Tabela 5. 5 Tabelë përmblledhëse e rezultateve

% misrit në mostër	10	20	30	40	100
% peshë	7,3	5,4	4,25	3,5	0,15
% volum	3,0	3,7	2,25	4,4	0,2

Në bazë të përqindjes së misrit të përdorur në mostra është ndërtuar grafiku i cili paraqet ndryshueshmërinë e % në peshë të etanolit të përfuar nga paratrajtimi, fermentimi dhe distilimi i mostrave të cilat përmbajnë sasi të ndryshme etanoli.



Figura 5. 3 Varësia e etanolit të formuar në % në peshë nga % e misrit të përdorur në secilën mostër

E njëjta procedurë ndiqet dhe për % në volum



Figura 5. 4 Grafiku që tregon varësinë e etanolit të formuar në % në volum nga % e misrit të përdorur në secilin mostër

CONCLUSIONS

- In the work presented in these paper, the possibility of bioethanol production in the organic farm has been examined. The idea has been evaluated from the selection and evaluation of the potential of raw materials through continuous trials on bioethanol production, the investigation of simple pretreatment methods for the materials, and finally, the simulation of the biorefinery concept on the farm and the development of a model for the biorefinery.
- Ethanol potentials from selected raw materials (corn, rye, clover, grass, animal manure and whey) were measured and evaluated. All investigated substrates were suitable for energy production through yeast fermentation. Maize and rye have been characterized for the highest potential. The silage method has been evaluated for its compatibility with the lignocellulosic ethanol production process. Corn, rye, clover and corn straw were ensiled under laboratory conditions and used as substrate in yeast fermentation. Promising results were obtained, concluding that silage is a very efficient wet storage method which can also be called a biological pretreatment method for the second generation of ethanol production. Furthermore, ethanol production by *K.marxianus* from organic whey through a continuous process resulted in a higher ethanol productivity.
- However, for an efficient conversion of materials into products of industrial interest, several obstacles must be overcome. The search for microbial strains suitable for large-scale cultivation, producing enzymes with suitable characteristics in the biotechnological processes to which they are intended, is of great importance.
- However, the biggest concern still remains the cost. Many studies are being conducted on bioethanol to improve its productive efficiency. Also, some of the new technologies are very effective but for industrial use, it is of great importance
- Experiments showed that whey is a suitable medium for ethanol production and can be successfully used in the on-farm biorefinery concept. Based on the results of the laboratory experiments and additional data, the simulation model for the biorefinery on the farm was built.
- The search for "clean technologies", using alternative raw materials in order to obtain products of industrial interest, with low energy costs and waste reduction as well as economically favorable has been encouraged by environmental issues in recent years. Research concerns the use of waste Bioethanol production from cereals (maize) and important celignocellulosics in bioprocesses, cultivating microorganisms that produce enzymes such as cellulases, xylanases, ligninases and other types of enzymes.
- These enzymes have potential for various biotechnological applications and in recent years special attention has been given to the destructuring, hydrolysis and saccharification of lignocellulosic materials in order to obtain fermentable sugars that can be converted into second

generation ethanol by microorganisms. **Further investigations** led to the development of a techno-economic model, where five scenarios for farm energy production were evaluated.

- The purpose of the modeling tools presented for both industrial scale and small scale was to build a platform for biorefineries of different sizes. Simulation models can be edited and adapted to specific needs.
- In this way, on-farm bioenergy production as well as large-scale lignocellulosic biorefinery can be brought closer to reality. On-farm biorefinery development requires a further update and optimization of the processes involved as well as the establishment and adaptation of simulation models that can help the successful creation of such a facility that meets specific needs.
- Several configurations should be modeled and then the most suitable ones selected. These configurations may differ from each other due to specific farm requirements. New process solutions such as: the silage method (presented in this thesis) and modern fuels or new generation fuels which are still in the laboratory stage, may be the answers of the future.

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**JAPANESE CULTURAL PRODUCTS BASED ON THE RELATIONSHIP WITH
NATURE TO PROMOTE ENVIRONMENTAL CARE AND AWARENESS**

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Abstract

Introduction and Purpose: The purpose of the present paper is to look at Japanese cultural products which have to do with nature and the human beings' relationship to it and the way the promotion of these traditions and practices to cultures outside Japan can be connected to the current concern for environmental care. Supranational organizations such as the European Union promote through policies and cultural events the relationship between the environment and the health of human beings.

Materials and Methods: A cultural awareness approach, combined with political sciences study of the European Union policies, together with the relationship with art, or culture in general, and ideology will be used for analysis. Japanese culture traditions and practices such as forest bathing (shinrin-yoku), which includes taking walks in nature, meditating and doing breathing exercises, enjoying the beauty of the cherry blossoms, writing haiku poems about nature and the present moment can be seen as very meaningful in the context of today's world. Our main value today at world level is concern for the environment, which comes with concern for the healthy living conditions for the human beings. According to Shintoism, the native religion of Japan, we human beings are not above nature, but we are a part of it. Nature is part of the setting of Buddhist temples and even personal homes, as they offer large openings towards the seasonal landscape.

Results: The soft power of Japan, which ensures the attractiveness of its cultural products for other cultures, works hand in hand with promotion for environmental care.

Discussion and Conclusion: Japanese traditions and practices help to make attractive the environmental concern for those interested in Japanese culture.

Keywords: Cultural empathy; Ideology; Haiku; Shintoism; Environmental policy

INTRODUCTION

Japanese cultural products are becoming increasingly popular in the Western world, as they are constantly promoted through various means, including through popular culture books. The Japanese culture's connection with nature is famous, and it can be identified in various practices and traditions, such as meditating in a Japanese Zen garden (Goto & Naka, 2015), the presence of nature in the setting where temples are located, the large sliding window and door screens openings in traditional homes, temples, to the point where we can refer to the "Japanese way of designing with nature" (Beita, 2010), the practice of forest bathing (shinrin-yoku), and also their own art is

concerned with elements and settings in nature, throughout their entire history of the arts. Shinrin-yoku is a practice made popular for the general public by the book with the same name, written by Miralles & Garcia (2020). This is the practice consisting of walking along paths in the forest, contemplating nature, meditating, doing breathing exercises, while inhaling the scent and oils of plants which support the forest's health in order not to allow bacteria to invade them. For human beings, these plants that support the forest's health also help improve immunity. Such walks and meditation practices are examples of relaxation, living in the present moment, and, therefore, escape from stress, an illness which affects anyone on a daily basis, as we hear from popular science articles that raise our awareness to such issues related, especially, to urban life. Haiku and haiga poems are frequently associated with the topic of nature. Haiku is a type of short poem, three lines, and 5-7-5 syllables, having a seasonal reference, and thus grounding the poem in the here and now. Mindfulness is a simplified way of looking at Zen Buddhist meditation practices, as it helps us focus on the here and now, and on our current relationships, as well as on the context of communication we find ourselves in at the present moment. Haiga poems resemble haiku poems, which work together with a photograph or a painting in order to create a meaning beyond what is being said. Therapy through haiku poems is a usual practice nowadays, and it can be used to increase awareness of someone's own feelings, as well as to increase awareness of the present time and surroundings. The seasons are, after all, affecting anyone's emotional and, eventually, physical well-being, which makes nature a part of everyone's life. Therefore, the practices and traditions, and, in fact, all the cultural products of Japan related to nature can easily be found relevant by members of other cultures. We can also include in the discussion the Cherry Blossoms Festival, which has been popularized all over the world and taken over by many members of other cultures. In Bucharest, Romania, where the author of the present paper lives, there is, in Herastrau Park, a Japanese Garden where, every year, the Cherry Blossoms Festival is celebrated, during weekends, with picnics with family and friends, just as it is enjoyed in Japan. It is an occasion to reflect on the beauty and on the ephemerality of the cherry blossoms, to enjoy them, and to accept that they do not last for long before their petals fall down.

The topic of nature is nowadays in strong connection with the environmental care as value and practice all over the world. We are more and more concerned about the status of our planet, and of various types of human activity that can help preserve the natural environment. Supranational organizations such as the European Union encourage the protective action for the environment. Our own health depends on the way we preserve our environment, and factors such as pollution may have negative effects on our bodies' health. As an example, air pollution may lead to changes that can be treated, consisting in respiratory function issues and function of lungs, in reactivity and inflammation of the airways, and even issues causing mortality, such as severe respiratory issues (Folinsbee, 1993). The beauty of nature, as promoted through Japanese culture traditions and practices, can motivate members of non-Asian cultures to take action against environmental destruction. Little actions such as not throwing away plastic bottles in nature can help a lot benefit the environment.

As members of other cultures realize how beautiful nature can be viewed through the perspective of cultures such as the Japanese culture's traditions and practices, since Japan is a culture paying lots of attention to the relationship between man and nature, since the oldest times, they are going to feel motivated to protect and preserve it.

The ideology of today's world encompasses values related to environmental care and culture awareness. The foundational definition of ideology is the following "a system of interrelated thoughts and ideas" (Dumoulin, 2021). Cultures can be defined as patterns of thinking and doing,

according to Baciú (2012), a definition which resonates with that of ideology. Cultures and ideologies do intersect, as they provide guidelines for the lifestyle, mindset and values of people living at a certain time, in a certain space.

The understanding and acceptance of members of other cultures is promoted through European Union policies, the same way as environmental care values are. Practices to support these values can include making them attractive through taking over traditions, rituals and practices with the culture identity manifestations grid devised by Baciú (2012).

One of the first articles dealing with the topic of the closeness between nature and environmental concerns, as well as with the notion of nature as a bridge between Eastern and Western world, is the one by Earhart (1970). The Eastern world traditions emphasize, according to Earhart (1970), a harmonious relationship of human beings and nature. According to Earhart (1970), for students belonging to American culture it can be both fascinating and liberating when they find out that there is a religion, namely that of Japanese culture, that both “appreciates the beauty of nature” and, at the same time, considers nature to have attached to it “a sacred value.”

CONCEPTUAL FRAMEWORK

Nature and Japanese Religions

The Japanese native religion, Shintoism, shows a very strong relationship between man and nature, in the sense that man is a part of nature (Hara, 2003). In Western cultures, usually, man is situated above nature, and in control of it. The hierarchy between man and nature is, therefore, different with respect to Western and Asian cultures. With Shintoism, nature is portrayed as beneficial, since it is believed that there are good spirits in nature, called kami (Breen & Teeuwen, 2013; Ono & Woodard, 2011).

Zen Buddhism is a philosophy more than a religion, according to Western culture standards, which focuses on the focus on the present moment (Katagiri, 2008), as well as on becoming aware of the ephemerality of every moment in our lives (Lomas et al, 2017). Nature is part of this type of philosophy or religion. We can, as Western culture members, call Zen Buddhism a philosophy, since it deals with the ephemerality of life, and with the present moment being the only one that we actually have. Zen Buddhism may be considered a religion, since it deals with meditation practices (Suzuki, 1991), yet it does not involve any instance resembling God, or intermediaries, such as saints, as we are used in Western culture religions. Nature as part of religion is specific to Japanese culture. Nature becomes part of the meditation practices, which, in Japanese culture, are related to religion, not to philosophy, as in Western culture. In Western culture, religion is related to a reality beyond what is going here and now. In Western cultures, spirituality related to religion has to do with a completely different realm than the secular reality one. It is related to a reality beyond.

The Concept of Environmental Policy

It was only in the 1960s that the “environmental revolution” appeared (Baumol & Oates, 1988).

It was within the context of “the political and economic trend of the early twenty-first century” when the subject of environmental policy came to the attention of the public (Baumol & Oates, 1988; Kraft, 2021).

Within the context of the European Union, the environmental policy includes the following aspects: “water or air pollution, chemicals regulation or the fight against climate change” (Delreux & Happaerts, 2016).

According to Kelemen (2010), “The growing power of environmental interests in Europe from the late 1980s, coupled with dynamics of EU policy-making led the EU to be committed to ambitious environmental policies.”

A public policy is clearly a collective concern, which promotes certain values, mindsets, and practices.

METHODOLOGY

Data collection and examination

The present paper relies on the Japanese culture traditions and practices, which are about nature and the strong relationship between man and nature. The bond between human beings and nature may be considered to be a universal one, since it is a universal fact that we all depend on the crops for our survival and on various resources offered by nature for our well-being. Drinkable water is one of the resources that can be classified as basic necessities.

However, in addition to the basic needs aspect for survival, we can notice, with respect to Japanese culture traditions and practices, how there is a strong philosophical and a strong spiritual dimension to the practices of admiring the beauty of nature, since what is beautiful in nature is ephemeral, e.g. the beauty of the cherry blossoms, since they can only last for a short amount of time. Additionally, admiring the beauty of cherry blossoms is a means of situating and grounding our experience in awareness of the here and now. We are all familiar with the practice of mindfulness, which is about a strong focus on the situation going on at the present moment and our relationship with the others at a given moment, as well as on our focus on interacting with the others in a way that is the most beneficial for both parties.

Practices such as meditation which also increase the focus on the present moment and context include forest bathing or shinrin-yoku and Zen Buddhist meditation in the setting of Japanese Zen gardens. Nature is not a simple beautiful sight, or beautiful setting where we can relax, but also a source of spirituality. It can be incredible for Western culture members to consider closeness to nature as a religion, including the Shintoist one, according to which there are good spirits all over around us in nature, called kami.

Analysis of the research problem

The question under analysis is how does the soft power of Japanese cultural products related to nature fit in the current ideological trend of environmental protection and concern with environmental care. We could start from considering environmental care preoccupations within the context of a culture, or subculture, within the larger, mainstream culture nowadays. This is because we know of various alternative lifestyles which include environmental care concerns, such as zero waste lifestyle (Kalkaja, 2016), which means recycling and not wasting any of the items someone is using on a daily basis. Other examples include food subcultures, as some food companies try to reduce the carbon footprint everyone makes while living on Earth, such as in the example related to a type of mozzarella cheese that is microbe-based, and which is produced by Superbrewed Food, a

US-based food company, and which is about a microbe-based protein that was created similarly to brewed food, namely through an anaerobic fermentation process (Dar, 2021).

The Japanese culture scores high on the soft power dimension (Hastrom, 2015; Otmazgin, 2008; Smith, 2012), meaning that Japan has cultural products which are perceived as very attractive by other cultures. Its cultural products include the traditions and practices related to Zen Buddhist meditation about the here and now, as well as about the ephemerality of everything in this world, together with the spirituality existing in nature through good spirits such as kami within the religion of Shintoism. In Japanese culture, we witness, as members of Western cultures, a fascinating and unusual, for us, combination between philosophy, religion, and the arts, in relation to the topic of nature.

In turn, this fascinating mixture and the way in which we tend to adapt certain other cultures' cultural products to our own culture and to integrate them within our own culture, through borrowing or, in some cases, through adaptation, as we try to explain the religion of Zen Buddhism and Shintoism through philosophy and spirituality to other Western culture members, to make them more familiar to them, can serve functional purposes. In this case, ideology can turn to cultural products made popular through soft power (Nye, 2021) and cultural contact, in such a way as to make everyone outside the culture of Japan to look differently upon nature, to realize how beautiful it can be and how deep our relationship can be towards it. We can look at nature beyond its simply decorative role in public parks and gardens, as well as within decorative areas in the city.

Model of the Research

The popularity of a culture other than our own and its cultural products which are borrowed are not innocent happenings. They serve ideological purposes, such as, in this case, a promotion of the relationship human beings can have with nature. The attractiveness of the Japanese culture's traditions and practices is presented through the aspects of spirituality, religion, philosophy and art, as well as meditation and mindfulness. Mindfulness, as we can infer from the research done by Gethin (2011), overlaps the one of Zen Buddhist meditation, focused on the here and now and on ephemerality. What is more, "The Buddhist technical term was first translated as 'mindfulness' by T.W. Rhys Davids in 1881" (Gethin, 2011). Additionally, according to Gethin (2011), starting with the 1950s, "some definitions of mindfulness became more informed by the actual practice of meditation," which can be interpreted as the concept of mindfulness overlapping more and more the concept of Zen Buddhist meditation. The term mindfulness is very popular nowadays, and it involves not just our relationship with nature and the natural environment, but also our relationships with the others based on our focus on the present moment and what we are doing at the present moment.

The research methodology relies on, in addition to ideological and cultural context, as well as on the concept of soft power in the promotion of environmental care practices, on cultural awareness (Tomalin & Stempleski, 2013) and cultural analysis (McGuigan, 2009). Ideology is a means of explaining how the Japanese cultural products are used as tools to reinforce the European Union ideology of environmental care, which is present in its environmental public policy (Vogler, 2011). Understanding other cultures and respecting different ways of thinking and doing, different mindsets and values, as well as different lifestyles, as well as promotion of knowledge about other cultures, and cultural empathy serve as background for the way in which certain cultural products are used as tools to reinforce certain values which are valid at international level.

Such a methodological framework helps us understand how cultural products taken over from other cultures can be used as tools to reinforce certain values active in our society at a certain time. Indeed, the environmental care value becomes more relatable once attractive practices such as the Japanese ones are being promoted and practiced.

CONCLUSION AND DISCUSSION

We can realize how much our own activities, as well as mental and physical well-being depend on our relationship with nature. Japanese culture teaches us not to intervene much in the natural environment, since it is beautiful the way it is. In Western cultures, on the contrary, in gardens, the tendency is to modify and intervene in the way the gardens look like as much as possible.

Visible differences in practices and traditions in various cultures can be sources of discovering different ways of doing and thinking, and to realize that the practices and traditions in our own culture do not represent an absolute truth and the only way to live in the world at a certain moment in time. We can reconsider what we have taken for granted and known about the world we live in. In addition, we can see how what we have been told in an abstract manner about the importance and beauty of nature, and environmental care in preserving spaces of nature are presented in a very attractive and deep, spiritual manner through the frame of Japanese cultural products and Zen Buddhism, as well as Shintoism. Practices such as forest bathing, the Cherry Blossoms Festival, the practice of the arts such as painting elements of nature and meditating, as well as writing poetry based on the immediacy of the here and now function of what goes on according to the current season, can throw an attractive light on the principles and values of nature preservation.

Such attractive cultural products can function similarly to the advertising campaigns and advertisements, in that a certain value in our case gets a concrete form of practice and tradition which is very attractive and deep. In our current world, we often hear concerns over losing touch with spirituality and with nature. In the past, in rural areas, human beings were always depending on the products of the natural environment and their everyday living activities were organized around the time of year and the work in the fields. Planting and gathering the crops were among the main events in the lives of people living in rural areas. Nowadays, with the large-scale movement of the population from rural to urban areas the dependence on and connection with nature are reduced. Still, issues such as well-being and seasonal affective disorder, which occurs in the months with less light, e.g. autumn and winter, can show that we still react to nature and that nature is never absent completely from our lives. In addition, when we speak of smart cities we also speak of the importance of green areas in urban spaces.

Japanese cultural products related to nature can promote environmental care since they can be used to educate people by presenting them with these traditions and practices which resemble stories. They are highly developed practices, and not simple rules and laws or moral principles according to which we can guide ourselves. Stories are always part of our education, and the way traditions are practices including nature are structured in the Japanese culture resemble their structure a lot, since they are both attractive and coherent. While these traditions and practices have value through interpretation and reflection, they also have concrete elements and actions we can do in order to practice these traditions.

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**CONSERVATION OF TOURISM RESOURCES IN U MINH HA NATIONAL PARK,
VIETNAM**

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Abstract

Tourism resources are all-natural, cultural and social factors that can attract tourists to the destination. Tourism resources in national parks not only create biodiversity but also are the premise for tourism development. One of the characteristics of tourism resources is their vulnerability. Therefore, the problem is that the exploitation of tourism resources must be associated with conservation and this is vital for national parks and tourism activities. This study was conducted to explore the conservation activities of tourism resources in U Minh Ha National Park. Research data was collected from a survey of 30 officers and employees working in the National Park. Descriptive statistics were used to analyze the data. The research results show that there are many measures used to conserve tourism resources. Of the proposed measures, five were rated as the most effective (over 50% of responses): Developing a canal network to limit the scope of forest fires and facilitate firefighting; Actively guarding and patrolling; Setting up warning signs for forest fire forecasting; Conserving water all year round, limiting forest fires; Releasing animals back into the forest. The research results supplement the theory of tourism resource conservation and the practice of tourism resource conservation in national parks.

Keywords: Conservation, tourism resources, ecosystem, national parks, U Minh Ha, Vietnam.

INTRODUCTION

Tourism is one of the largest industries of the world. Tourism is vital for developing economics, contributing to the reduction of poverty, supporting a diversity of employment, being the major export sector and the primary source of foreign exchange earnings of many countries (SNV

Netherlands Development Organisation, 2009). The development of tourism has a close relationship with tourism resources (Pham et al., 2000) because they are the basic element in making attractions and forming tourism products. All factors that can stimulate tourists' travel motivation are exploited by the tourism industry and thereby generate economic and social benefits, which are called tourism resources (Dong & Vuong, 2001). One of the characteristics of tourism resources is their vulnerability. Therefore, the exploitation of tourism resources must comply with the principle of conservation. Conservation of tourism resources is to preserve them, not to let them be damaged or lost. Conservation of tourism resources in general and conservation of tourism resources in national parks, in particular, plays an important role in preserving natural and cultural resources (biodiversity), protecting the environment, ensuring long-term livelihoods and sustainable tourism development.

Minh Ha National Park is one of two national parks located in the Mui Ca Mau World Biosphere Reserve, with an area of 8,527.8 ha, divided into 3 functional areas: peatland ecosystem conservation area (2,593.7 ha), wetland ecosystem restoration and sustainable use area (5,190.5 ha), administrative service area (743.6 ha). In addition, the national park also has more than 25,000 ha of buffer zone. The typical forest ecosystem in the National Park is flooded, waterlogged, and acidic Melaleuca forests on peat soil. This is one of the unique and rare forest types in the world, and is part of the 'green lungs' of the planet Earth. The typical forest ecosystem in the National Park is flooded, waterlogged, and alum-soaked Melaleuca forests on peat soil. This is one of the most unique and rare forest types in the world and is part of the 'green lungs' of the planet Earth. From a tourism perspective, the forest ecosystem in the National Park is an extremely valuable tourism resource. The impact of climate change and tourist activities requires the National Park to preserve the forest ecosystem in general and tourism resources in particular to ensure ecological integrity and sustainable tourism development. This study was conducted to explore tourism resource conservation activities as well as conservation activities that are considered to be effective in tourism resource conservation in U Minh Ha National Park. The study contributes to supplementing the theory and practice of tourism resource conservation.

MATERIALS AND METHODS

Theory of tourism resource conservation

Tourism exploitation can cause some damage to tourism resources. Therefore, tourism resource exploitation must pay great attention to nature conservation and ecological balance, and at the same time avoid activities that destroy natural landscapes. Once nature is destroyed, it is difficult or impossible to restore. Therefore, conservation is considered a very important principle in resource exploitation. There are many forms of tourism resource conservation. Intact conservation is the preservation of the original state of tourism resources, without human intervention. Development conservation is a form of both maintaining the current state and creating new forms of tourism resources to make them more diverse and unique. This is a common form of tourism resource conservation in national parks around the world.

Conservation of tourism resources is placed in parallel with the process of exploiting tourism resources. Conservation of tourism resources is not simply protecting the attractiveness of the destination but also protecting the general tourism environment. Once tourism resources are preserved, tourism activities at the destination can develop sustainably. Exploiting and using tourism resources appropriately will bring long-term benefits to the destination.

Research methods

This study was conducted based on three main methods. First, a literature review was conducted to gain a certain understanding of the topic and research area. Then, fieldwork was conducted to determine the accuracy of the content in the literature as well as to support the design of the questionnaire and to gain a practical understanding of the research area. Finally, a questionnaire survey method was used to collect information on conservation activities and conservation activities were evaluated as effective. To meet the requirements for descriptive statistical analysis and to be consistent with the sample population, 30 respondents (management and staff) were interviewed. The survey data were analyzed using descriptive statistical methods using SPSS software.

RESULTS

Tourism resources in U Minh Ha National Park

The two prominent tourism resources in U Minh Ha National Park are flora and fauna. Due to the seasonal flooding, the flora in the National Park is a mixture of Melaleuca forests and seasonally flooded grasslands. In this ecosystem, there are three main types of vegetation: primary Melaleuca forests, planted Melaleuca forests and grasslands. Typical tree species in the National Park include Melaleuca Cajuputi, Alsbiuia Spathulata, Ilex Cymosa, Melastona Pelyauthium, Lienala Spinosa, Lygedium Myerephyllum, Enodia Lepta, Aetenychia Laurifellia, Phragmites Karka, Stenochleân Palustrie, etc. The wetland flora creates favorable habitats for many species of wildlife. In addition to the vegetation, the National Park also has many canals that provide an ideal environment for many species of freshwater fish to grow and develop. Many animals choose the National Park as their home because of its forest ecosystem and environment that is suitable for them. Moreover, the National Park is a protected area where wild animals can survive and gather. Typical animals here include Python reticulatus, Elophe radiata, Ophiophagus hannah, Manis javanica, Anthonyx cinerea, Lutra sumatrana, Vive zibetha, Viverricula indica, Prionailurus bengalensis, Prionailurus viverrinus, Cynoterus brachyotis, Pteropus vampirus, etc. The forest ecosystem in U Minh Ha National Park is a typical tourism resource for the development of ecotourism. For a long time, this place has been considered a suitable destination for tourists who love to explore wild nature and learn about the diversity of ecosystems. By 2022, the National Park welcomed 12,787 visitors, and earned VND 1,206,180,000 (Data provided by the National Park Ecotourism Department, 2023). The prominent types of tourism in the National Park are visiting wetland ecosystems, learning about biodiversity, exploring natural landscapes, participating in recreational activities, enjoying cuisine, etc. Under the impact of climate change, tourist activities and local people's livelihoods, the National Park Management Board has carried out many activities to conserve tourism resources and this is shown in the following content.

Conservation activities of tourism resources in U Minh Ha National Park

Conservation of tourism resources in U Minh Ha National Park is to conserve the flora and fauna in general, and the ecological values for tourism in particular. The focus of conservation is to maintain vegetation cover, diversity and abundance of fauna, and unique habitats for ecotourism development. The survey results show that U Minh Ha National Park has implemented many measures to preserve tourism resources (see Table 1). Afforestation is the most popular measure (96.7%). According to the Management Board, every year, the National Park organizes reforestation in vacant land areas and places where forest trees have died. Education and propaganda for tourists

to protect natural resources and the environment were also chosen by many respondents (93.3%). The National Park has carried out many activities to interpret and educate the environment for tourists. Releasing animals back into the forest, and environmental education and propaganda for local people received 86.7% of respondents' choices. Recently, the National Park coordinated with the Mobile Forest Ranger and Forest Fire Prevention Team under the Provincial Forest Protection Department to release wild animals back into the forest that were voluntarily handed over by local people and discovered by forest rangers. In addition to doing a good job of propaganda, forest protection and management forces also actively raise awareness and knowledge of the community about forest management and protection, fire prevention and fighting, and protection of wildlife in the National Park. Waste collection and treatment, and forest fire prevention are also implemented to contribute to the conservation of tourism resources in the National Park. An officer at the National Park said, "The National Park regularly collects and treats waste within the National Park and proactively develops plans for forest fire prevention and fighting". In addition to the above measures, forest protection and management forces also regularly patrol and control activities that show signs of affecting the ecosystem or illegal forest exploitation.

Table 1. Measures of tourism resource conservation in U Minh Ha National Park

Measures of tourism resource conservation	Frequency	Percent*
Afforestation	29/30	96,7
Forest fire prevention	17/30	56,7
Waste collection and treatment	21/30	70
Releasing animals back to the forest	26/30	86,7
People propaganda and education	26/30	86,7
Tourist education and propaganda	29/30	93,3

*Multiple choice question

Effective measures to conserve tourism resources in U Minh Ha National Park

Effective conservation of tourism resources will maintain the attractiveness of the destination and contribute significantly to the successful development of ecotourism. Logically, the attractiveness of the destination is maintained and enhanced, attracting a large and stable number of tourists, and increasing tourism revenue and profits for the destination. Research by Huynh & Ngo (2024) shows that the attractiveness of the destination has a positive effect on tourist satisfaction; tourist satisfaction has a positive impact on loyalty.

Table 2. Perceptions on the effectiveness of tourism resource conservation measures in U Minh Ha National Park

Effective measures of tourism resource conservation	Frequency	Percent*
Develop a network of canals to limit the scope of forest fires and facilitate firefighting	17/30	56,7
Actively guard and patrol	17/30	56,7
Set up forest fire warning signs	18/30	60
Retain water all year round, limit forest fires	17/30	56,7
Release animals back to the forest	18/30	60
Propaganda and education of people	14/30	46,7
Regulate water flow so that vegetation can grow well and animals have places to feed.	14/30	46,7
Propaganda and education for tourists	9/30	30

*Multiple choice question

Ecotourists, like to experience undisturbed natural areas, visit tropical forests, and observe birds, many other animals, trees, wildflowers, etc (Galley & Clifton, 2004; Weaver, 2002). Conservation of tourism resources in U Minh Ha National Park focuses on natural entities, which is suitable for the interests of ecotourists. Unlike coastal protected areas, conservation of tourism resources invests heavily in structural solutions (construction of concrete embankments, soft dikes, fences, and soft walls), conservation of tourism resources in U Minh Ha National Park focuses mainly on non-structural solutions (see Table 2). The measures that are considered to be most effective in conservation of tourism resources are:

- Set up forest fire warning signs
- Release animals back to the forest
- Develop a network of canals to limit the scope of forest fires and facilitate firefighting
- Actively guard and patrol
- Retain water all year round, limit forest fires

CONCLUSION

Conservation of tourism resources is one of the very important strategies to achieve sustainability in tourism development in general and ecotourism in particular. Ecotourism depends on the integrity of tourism resources, so the conservation of these entities will ensure the long-term development of ecotourism at the destination. U Minh Ha National Park has implemented many measures to protect tourism resources, focusing on protecting flora, fauna and landscapes. Measures to conserve tourism resources are considered effective, focusing on minimizing forest fires, actively patrolling and guarding, and regenerating flora and fauna. The motto of conserving tourism resources in U Minh Ha National Park is to take “prevention” as the main factor, “treatment” as the secondary factor and combine “prevention with treatment”. In addition, the National Park also implements the motto of conservation for development and development for better conservation conditions through ecotourism development. To preserve tourism resources in U Minh Ha National Park, in addition to maintaining the measures already taken, the National Park needs to focus on building a team of qualified, capable, and responsible staff to meet the requirements and tasks in the new situation; invest in modern facilities, from necessary equipment, means, and techniques to serve the work of preventing and combating biodiversity crimes.

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GEROVITAL H3 - A REAL FOUNTAIN OF YOUTH? - PROS AND CONS

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Abstract

Aging is a natural and multifactorial process of ongoing functional decline in cells, tissues, and organisms. Despite this, it is well-known that lifestyle choices such as diet, exercise, and sleep can slow it down. Moreover, expensive and more or less sophisticated supplements that claim to delay or reverse the aging process have been promoted in the last decades. Consequently, several chemical compounds or extracts such as collagen, resveratrol, curcumin, coenzyme Q10, hyaluronic acid, green tea extract, and *Ginkgo biloba* are sold worldwide in huge quantities. Gerovital H3, an original Romanian product, is the first drug specifically created to delay aging. It was developed between 1946 and 1956 by Prof. Dr. Ana Aslan and her school.

This paper aims to present the history of this controversial drug, which is based on the dental anesthetic procaine hydrochloride (novocaine), which is still extensively used in Romania as part of an anti-aging program.

The paper emphasizes that dosage and administration determine the subtle differences between anti-aging therapeutic and anesthetic effects. It also explains the drug's design and the relationship between pH and hydrolysis stability in the body.

To maintain scientific objectivity, the paper considers the severe criticism related to this geriatric product. According to the National Institute on Aging from USA, “except for a possible mild monoamine oxidase (MAO) inhibitor effect that would potentially ameliorate depression, there was no scientifically credible evidence supporting the claims that procaine is beneficial in treating age-related diseases or syndromes”. Besides, the U.S. Food and Drug Administration (FDA) banned it in 1982.

Keywords: Gerovital H3, aging, dental anesthetic, monoamine oxidase

**LAETRILE/ AMYGDALIN CONTROVERSY IN CANCER TREATMENT: END OF
STORY?**

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Abstract

After receiving a cancer diagnosis, a significant number of people refuse or delay the conventional treatments approved by the oncologists in favor of unproven alternative therapies, thus reducing their life expectancy. A plethora of natural or synthetic chemical compounds/ mixtures or therapies, such as hyperbaric oxygen therapy, coral calcium, colloidal silver, polarity therapy, lipoic acid, shark cartilage, and pangamic acid, have been promoted to treat or prevent cancer in humans, but poor and insufficient scientific evidence of effectiveness.

Amygdalin, a naturally occurring chemical compound, and Laetrile (a more straightforward semisynthetic derivative of amygdalin) are perhaps the most well-known of these alternative treatments. Numerous websites promote Laetrile and Amygdalin (often sold under the misnomer vitamin B17) as cancer-curing molecules. However, these claims are largely based on unsupported opinions and personal anecdotes, rather than robust scientific evidence. This paper aims to critically review all perspectives on the controversial use of Amygdalin and Laetrile in cancer treatment, shedding light on the lack of scientific backing for these treatments.

Upon thorough review of the published data, we have concluded that the purported benefits of Amygdalin and Laetrile and their efficacy in cancer treatment are not substantiated by controlled clinical trials. This paper presents these findings and offers potential explanations for the question “Could the Laetrile/Amygdalin case have been prevented?” that remains unanswered. Importantly, the paper underscores the necessity of relying on credible sources of information from reputable institutions such as the EFSA (European Food Safety Authority), EMA (European Medicine Agency), FDA (Food and Drug Administration), the EPA (Environmental Protection Agency), the IARC (International Agency for Research on Cancer), to ensure the dissemination of accurate and reliable information.

Keywords: amygdalin, laetrile, cancer treatment, cyanide poisoning

OPTIMIZATION OF REACTION CONDITIONS FOR α -AMINOPHOSPHONATE SYNTHESIS USING DESIGN OF EXPERIMENTS METHOD

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Abstract

α -Aminophosphonates represent a notable subset within the broad category of phosphonates, distinguished by the presence of an amino group at the α -carbon atom. These compounds have garnered significant attention, particularly in the biological sciences, due to their unique chemical structures and versatile functional properties¹. In medicinal chemistry, α -aminophosphonates are especially promising, often demonstrating bioactivity and pharmacological effects. Their ability to mimic the structural features of natural amino acids enhances their relevance in drug design and development². This versatility positions them as potent candidates across a wide range of therapeutic applications, including antitumor, antibacterial, α -glucosidase inhibitory, virucidal, and anticancer properties.³

In this work, we aim to advance the field of α -aminophosphonates through the development of a new methodology utilizing the *Kabachnik-Fields* reaction with an organocatalyst under environmentally friendly conditions. We employed the design of experiments method to optimize the reaction conditions, investigating the influence of three key physicochemical factors: catalyst amount, reaction time, and medium temperature, using a full factorial experiment design.

ANOVA confirmed that the three selected factors were statistically significant. The proposed model was validated through the calculation of the determination coefficient (R^2) and the adjusted determination coefficient (R^2_{adj}), yielding values of 99.25% and 97.51%, respectively. Response surface analysis enabled the identification of optimal operating conditions for the preparation of a series of α -aminophosphonates with high chemical yields.

Keywords: α -aminophosphonates, *Kabachnik-Fields*, Eco-friendly conditions, organocatalyst, the design of experiments.

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IMPACT OF AMINE ADDITION ON THE DEACYLATION OF BENZYLIC ACETATES

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Abstract

Enantiopure alcohols are crucial in the biological realm due to their selective interactions with biological systems. These chiral molecules often serve as essential building blocks in the production of pharmaceuticals, where their enantiomeric purity significantly impacts the drug's efficacy and safety⁴. Additionally, they play a vital role in the synthesis of enantiomerically pure pesticides and herbicides⁵. Their significance also extends to their use as effective ligands in asymmetric synthesis, functioning as chiral auxiliaries, chiral ligands, or starting materials for creating more complex chiral molecules.⁶

However, synthesizing these enantiopure compounds is challenging due to the complexity involved in achieving selective transformations. As the demand for more efficient and selective synthesis methods increases, enzymatic kinetic resolution has become a prominent strategy for obtaining enantiomerically pure compounds. This method capitalizes on the high efficiency of lipases, which operate under mild conditions and are in line with several principles of green chemistry.

The success of enzymatic kinetic resolution depends on various factors that influence both reactivity and selectivity. In this context, we describe the enzymatic kinetic resolution of racemic acetates through deacylation and examine the impact of parameters such as the nature of the enzyme and the hydrophobicity of the reaction medium. Moreover, the addition of specific additives has been shown to significantly affect the enzymatic process, enhancing enzyme performance and further improving the reaction's efficiency and selectivity.

Keywords: Kinetic resolution, Benzylic acetates, Green chemistry, enzyme, Additives.

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**INVESTIGATING VOLATILITY DYNAMICS IN GREEN BONDS, RENEWABLE
ENERGY, AND CRYPTOCURRENCY MARKETS: EVIDENCE FROM DCC
MODELING**

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Abstract

This paper investigates the impact of green finance volatility on the renewable clean energy and cryptocurrency markets. It uses the S&P Green Bond Index (RSPGB) and the S&P 500 ESG Index (RSPESG) to represent green finance, and the S&P Global Clean Energy Index (RSPCE) as a proxy for the renewable energy market. The S&P Bitcoin Index (RSPB) serves as a proxy for the cryptocurrency market. A Dynamic Conditional Correlation (DCC) model is employed on daily data spanning from April 30, 2014, to May 31, 2024. The analysis reveals volatility among the variables studied. The DCC results show that there is a volatility spillover effect from green bonds to renewable energy, and from ESG investments to both renewable energy and cryptocurrency markets, affecting both short-term and long-term periods. Also, the spillover effect from green bonds to cryptocurrency is only evident in the long term, indicating that portfolio diversification benefits are available only over a longer horizon. This study has substantial implications for policymakers, investors, and portfolio managers.

Key Words – Green bond, ESG, Cryptocurrency Market, Renewable Energy, Volatility Spillover, Dynamic Conditional Correlation

TRANSPORT OF ELECTRONS AND IONS IN THE GAS

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Abstract

In the absence of experimental and theoretical results, a simple one was applied technique of cross-sectional assessment and separation of reactive from elastic collisions (Denpoh-Nambu theory). The Monte Carlo simulation technique was applied in order to calculate transport parameters in DC electric fields. To determine of a complete set of sections of great importance is the shape of the section to be created complex. It is mainly used with a collision frequency that does not depend on energy and is calculated from the average life of the complex, although numerous measurements of this cross-sections indicate that they decrease sharply with increasing energy. In case it's time for them life is short, the cross-sections for the formation of complexes increase with growth pressure due to stabilization by triple collisions. For the first time it is in the literature the determination of transport parameters of ions in induced polarization potential with the participation of exothermic reactions of the association and ion identity change reaction. The transport ones were previously calculated coefficients for CF₄ electron scattering in the presence of CF₃, CF₂, CF, F₂ and F are included in global models. Calculations in real mixtures are given used for plasma etching (Ar, CF₄, O₂). BF₃ gas is used in gas plants thermal neutron detectors, and it was also used as a substitute for B₂H₆. BF₃ is used for implantation because B is a p-type dopant in amorphous Si films which used in the production of solar cells and integrated circuits.

CLIMATE CHANGE AND ITS EFFECTS ON THE TOURISM INDUSTRY IN ALBANIA

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Abstract

The article emphasizes the urgent need for responsible institutions in Albania, organizations addressing this issue, and business entities to take immediate measures and discuss ways to mitigate the future consequences of climate change, which are already being felt these last years. Climate change is an increasingly pressing global issue that poses significant threats to various sectors, including tourism. In Albania, the tourism industry, which has been growing steadily in recent years, is particularly vulnerable to the impacts of climate change.

Rising temperatures can make summer months uncomfortably hot for tourists, potentially reducing the attractiveness of coastal destinations. Prolonged heatwaves may also strain infrastructure such as water supply and energy systems. Coastal erosion and flooding due to rising sea levels threaten beach resorts and coastal towns, leading to the loss of valuable tourist attractions and damage to infrastructure, negatively affecting the tourism industry.

Climate change poses significant challenges to Albania's tourism industry, which is the main industry in the country, necessitating proactive measures to ensure its sustainability and growth. Developing cultural tourism, historical site visits, and eco-tourism can attract tourists year-round, reducing dependency on favorable weather conditions and spreading economic benefits across different regions. Effective policies and strategic planning are necessary to address climate change challenges. Government and industry collaboration is key to developing and enforcing these policies. Mitigating health risks related to climate change is essential for protecting tourists and residents. Measures such as improved healthcare services, early warning systems for extreme weather, and public education on health risks can enhance safety and well-being.

By adopting these strategies, Albania can effectively address the impacts of climate change on its tourism industry. Ensuring resilience, sustainability, and diversification will safeguard the sector, contributing to the country's economic development and preserving its natural and cultural assets for future generations.

Keywords: Climate Change, Tourism Industry, Tourist, Future Generation, Economy.

INTRODUCTION

Climate change refers to long-term shifts in weather patterns. While it includes the trend of increasing average temperatures, it also involves the rising frequency of extreme events such as hurricanes, heatwaves, and floods. These phenomena are becoming more common and intense, significantly impacting the natural environment and daily life, posing new challenges for societies and economies in affected regions.

The large number of foreign tourists who are visiting Albania this year underscores the importance and need for the professional recognition, protection, and promotion of our National Heritage, both Cultural and Natural.

Cultural Heritage is fundamentally viewed by experts as a product of a long process that has provided various societies with a national and global treasure. This process includes not only tangible material heritage but also intangible elements, which constitute a "fragile" asset requiring micro and macro-level policies and development models aimed at preserving diversity, as the loss of this diversity is irreplaceable. The creation of this heritage has traversed through centuries and has been preserved up to the present day. It can be said that, in many cases, the preservation of heritage has also depended on chance (if we are permitted to describe it as such, especially in our country) due to its lack of recognition.

Albania has been a member of UNESCO (the United Nations Educational, Scientific and Cultural Organization), one of the specialized agencies of the UN, since 1958. Under the communist regime, no sites were listed until 1992, when Butrint was included for the first time as part of the World Heritage List due to its unique and irreplaceable value as a city where, different civilizations coexisted. Since then, Albania has had additional registrations on the World Heritage List, which have played an extraordinary role in recognizing the country on the international stage positively, thus also influencing the increase in tourist numbers.

Nowadays there are 9 sites (including Natural, Cultural and Spiritual ones, like: Berati, Gjirokastra, Lumi i Gashit, Rrajca, Iso Polifonike, Liqeni i Pogradecit, 2 Kodiket e Beratit etc), registered on the World Heritage List, which is significant for a small country like Albania in terms of both size and population.

Tourism, the main sector in Albania, important for the economic growth, is based on this Natural and Cultural Heritage.

Today, this heritage faces numerous challenges, making its protection a significant issue. These challenges include rapid climate change, natural disasters, inter-state conflicts, urbanization, and economic inequalities. This heritage forms the foundation of tourism, and particularly in the post-COVID-19 era, it has generated remarkable interest among both local and foreign tourists. In Albania, the tourism sector is a major driver of economic development, employing a large number of people, with 70% of the workforce being young individuals.

Thus, the country's economy heavily relies on this sector, with its revenues supporting thousands of families and contributing to the state budget. The appeal of Albania to foreign tourists is largely due to its natural beauty, coastline, and its Cultural and Natural Heritage. This asset, valuable on both national and global scales, urgently needs preservation and effective management. Recent years have seen a serious threat to this heritage from climate change and global warming, which bring unprecedented high temperatures and their associated impacts.

This year, the large number of foreign tourists visiting Albania and exploring various destinations highlighted their significant interest in learning about the country's Cultural Heritage. Along with this interest, several problems also came to light, many of which had been neglected or overlooked for a long time.

OBJECTIVES

The primary objective of this paper is to underscore the imperative and significance of raising awareness among young people in Albania regarding the existence of this future challenge. Combined with increased investment from state institutions in the future, this awareness campaign can significantly impact the prosperity of these areas, the development of tourism and the ways to keep the young generation aware of the effects of climate change in the future.

1. The initiation of methods from state institutions together with the businesses working in these fields would facilitate advancements in research and shed light on new data, which could hold significant importance for the entire country economy.
2. This awareness of the public opinion and the new measures would have a positive impact in the future for young generations which is the biggest concern now and for the future. Furthermore, the unveiling of new data would enhance media and social network promotion, further piquing the interest of various demographic groups, including local and foreign tourists encouraging visits to the area. These increasing number of tourists are going to help the Tourism Industry to raise the wages of service staff which would be an important step to keep these young people staying in the country. At the other hand the increasing number of tourists could be the biggest problem for the tourism Industry if there would be nothing regarding the climate changes.
3. The increasing number of tourists and visitors would stimulate the establishment of new businesses, accommodation structures, and employment opportunities for local youth and residents. Education Institutions are going to be an important step for bringing up issues such as the globale warming and climate changes in the future.

OVERVIEW

Climate change is an increasingly pressing global issue that poses significant threats to various sectors, including tourism. In Albania, the tourism industry, which has been growing steadily in recent years, is particularly vulnerable to the impacts of climate change.

The increase in the number of extremely hot days and the intensification of droughts during the summer have led to a significant rise in forest fires, pasture fires, and wildfires in green parks, with more than 100 fires reported annually. In some years, the recorded fires exceed 300, causing entire areas—particularly in Eastern Albania—to become devoid of trees or animals, which have been wiped out along with the forests.

Over the past 20 years, the seasons have gradually lost their climatic characteristics. Winters have become milder and shorter, while summers are increasingly hotter and longer, encroaching on the spring and autumn seasons. Despite the milder winters, nature occasionally brings 15-day periods of extremely low temperatures, where the thermometer drops to as low as -10°C , even in coastal areas, accompanied by rare frosts that cover 100% of Albania's surface. On the other hand, the summer season in these two decades has broken thermal records, with temperatures soaring as high as 44°C .

Rising temperatures can make summer months uncomfortably hot for tourists, potentially reducing the attractiveness of coastal destinations. Prolonged heatwaves may also strain infrastructure such as water supply and energy systems. Coastal erosion and flooding due to rising sea levels threaten beach resorts and coastal towns, leading to the loss of valuable tourist attractions and damage to infrastructure, negatively affecting the tourism industry.

Climate change poses significant challenges to Albania's tourism industry, which is the main industry in the country, necessitating proactive measures to ensure its sustainability and growth. Developing cultural tourism, historical site visits, and eco-tourism can attract tourists year-round, reducing dependency on favorable

Biodiversity and forest ecosystems will be affected by climate change. Assuming a temperature increase of 1-2°C, it is predicted that forest ecosystems may be replaced by grassland ecosystems. The rise in temperature will cause different soil conditions, making the sustainable planting of forests in the mountainous grassland belt, up to 1900 meters above sea level, uncertain. With increasing temperatures, there will be a greater mixing of forest types. Sparse vegetation will become dominant, leading to the degradation of forests that hold environmental and economic value. Wetlands of national importance in the Vjosa Delta will change as a result of rising sea levels and higher temperatures in the aquatic environment.

The construction of hydropower plants will have a significant impact on wildlife, potentially causing the permanent loss of habitats and specific biotopes due to flooding, fluctuations in water levels, the spread of exotic species, and barriers to fish migration.

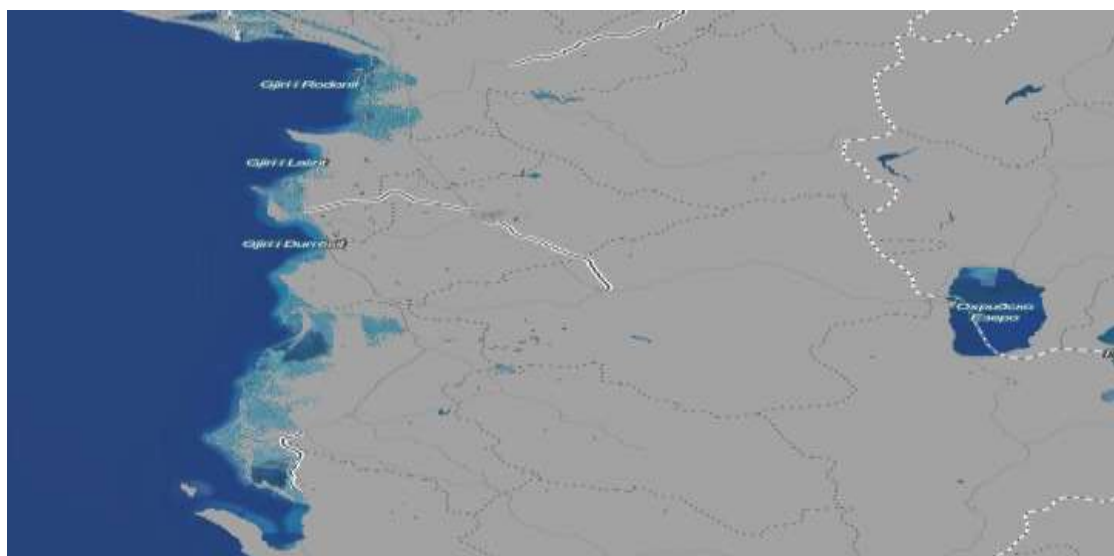
The rapid climate change or climate crisis that we have been witnessing in recent decades is caused and continues to be driven by the emissions of greenhouse gases from human activities, with the most common being carbon dioxide (CO₂) and methane (CH₄). This has led to a climate crisis where the climate is changing at an unprecedented speed, far beyond what the Earth has naturally experienced. In essence, the climate crisis is the consequence of global atmospheric pollution caused by humanity.

Climate changes in Albania have been observed since the late 1990s, but it was after the winter of 1997 that these changes became more frequent and more evident. Climate changes are observed in the average and absolute values of air temperatures and atmospheric precipitation, which are the two main elements of climate. Changes have also been observed in secondary elements such as the number of hot days or tropical nights, the increase in heatwaves and frosts, the length of dry periods, and the occurrence of various atmospheric phenomena outside the usual months.

Additionally, during the second decade from 2010 to 2020, which began with the floods in Northern Albania, residents were isolated for nearly a month by the waters that engulfed the counties of Shkodra, Lezha, Kurbin, and partially Kruja. Various urban areas faced isolated floods year after year until February 2015, when another massive flood endangered the lives and property of residents from Fier down to Gjirokastra.

The new map of Albania will look like this by 2050 with only a 0.5-meter rise in sea level:

A 0.5-meter rise in sea level is projected to cause significant changes in Albania's coastline by 2050. Coastal areas will experience increased erosion, loss of land, and potential flooding. Key cities and infrastructure along the coast may be at risk, and there could be substantial changes to local ecosystems and habitats. The impact will likely affect tourism, agriculture, and urban planning, necessitating adaptation and mitigation measures to manage these changes effectively.



A tropical-like storm swept through Albania from the North to the South, recording over 200 millimeters of rainfall in 24 hours—higher amounts than the monthly average for most western and southern areas. The high intensity of the rain within 2-3 days and the inflow of the Vjosa River from beyond the border forced it to overflow, flooding the entire southern area, sweeping away homes and anything in its path. It is precisely this decade that also contains the hottest five-year period in recorded climate history; the years 2015–2019 are the hottest years on record, not only in Albania but also in the region.

The rise in sea level as a result of global glacier melting has been more noticeable on the Adriatic coast, which has not only been eroded, but the water has advanced at least 50 meters inland. The encroachment of the coast by water has reduced green belts in western areas, while across the entire North-East-South stretch, forest belts have been damaged by logging and burning. The degradation of forested areas due to unregulated logging, natural or human-caused fires, is considered the greatest damage that Albanians have inflicted on the environment.

Concrete Proposals for Albania's Agreement on Climate Action

1. Energy: Albania should invest heavily in solar and wind energy, improve energy efficiency, and reduce energy production losses due to droughts in summer or other seasons.
2. Measures Against Rising Sea Levels: Nationwide measures should be taken to build breakwaters and seawalls, prohibit the extraction of gravel from riverbeds, release sediments held by hydropower dams, and relocate parts of cities affected by rising sea levels. In some areas, land should be filled and elevated with inert materials.
3. Clean Transport: Invest in modern electric public transport and railways to reduce air pollution in cities. Tax incentives should be provided for hybrid and electric cars, and investments in railways should be a priority.
4. Water Resource Conservation: Preserve water reserves by creating new reservoirs for agriculture and drinking water, reducing leaks in the network, reforesting mountains as trees capture vapors and create rain in mountainous areas, protecting rivers, removing small hydropower plants that destroy rivers, capturing and retaining rainwater, and reducing asphalt and concrete surfaces in cities to allow water to infiltrate underground layers and recharge groundwater reserves.

5. Greening the Country: Implement measures and plans to cope with heatwaves, such as creating shade along streets, planting more trees in cities, preserving existing trees, especially old ones, mandating the creation of green roofs to keep buildings cool in summer and warm in winter, and planting climbing plants on as many buildings as possible to keep walls cool.
6. Reducing Air Pollution: Decrease the production of cement/concrete, which causes significant CO2 emissions and atmospheric pollution.
7. Healthy and Environmentally Friendly Agriculture: Actions should be taken to reduce meat consumption, promote agroforestry, and high-nature-value agriculture, which should become the model for farming.
8. Increasing Ambition to Reduce CO2 Emissions: Raise the current target of 11.5% to 30% or more by 2030, aligning with the EU.
9. Promoting Circular, Recycling, and Artisan Economies in Cities.
10. Reforestation with Native Trees: Massive tree planting on every possible piece of land. Strict punitive measures for intentionally set fires and a ban on burning fields and plant waste.

For winter tourism, warmer temperatures may shorten the snow season, negatively affecting ski resorts. Changes in precipitation patterns and vegetation may also impact agro-tourism and rural attractions by altering agricultural practices and the appeal of natural landscapes.

General challenges include potential strain on tourism infrastructure due to increased temperatures and extreme weather, as well as health and environmental risks that could affect tourism. However, there are opportunities to develop climate-resilient infrastructure, adapt tourism strategies, and promote sustainable practices. Monitoring and adjusting to changing tourist demands and environmental conditions will be crucial for managing these impacts effectively.

Citizens almost equally agree that education and schooling contribute to healthy environmental habits and environmental awareness. This is a strong indicator that the public is aware of the role of family as a contributing factor in shaping people's environmental habits, but also that school is the best place to develop children's awareness on this issue.

Many people seem not to believe that their individual actions can make a significant difference, and the sense of responsibility is often influenced by the actions of others. Additionally, some are willing to accept environmental damage as a consequence of economic needs and growth, seeing economic growth as linked to environmental harm.

One of the most significant changes occurring in the 21st century is certainly the growing awareness of humanity's interdependence. Humanity is becoming aware that there are problems that no individual or state can solve independently and without the cooperation of others. These include issues such as land pollution, climate change management, global pandemics, mass migration, and many other phenomena before which individuals and states remain powerless if there is no joint and synchronized action. In this regard, the challenges of climate change are becoming increasingly serious, current, and acute with a record number of natural disasters. Extreme weather events like fires, floods, hurricanes, and heatwaves are much more frequent and intense, thus putting the "green agenda" on the table of many governments that until recently did not pay sufficient attention to climate change or were indifferent to these issues.

In recent years, Albania has been experiencing significant climate changes, which have manifested in a noticeable increase in temperatures beyond the norm and prolonged summer seasons.

Climate change knows no borders, contributing to the rapid degradation of the environment. An effective method to address the challenges of climate change is through cross-border cooperation.

The Western Balkans is also a region with significant potential for sustainable tourism due to its rich cultural heritage, diversity, attractive coastline, and historic cities. Tourism is one of the fastest-growing economic sectors in the region, and in most countries, it is expected that tourism will increase its contribution to GDP and create new jobs. Like the agriculture sector, tourism depends on natural conditions, particularly in coastal and mountainous regions. Climate change is expected to have a significant impact on mountainous environments, affecting tourism due to both the evolving nature of the industry and the changes in climate.

CONCLUSION

The European Commission (EC) officially adopted the European Union (EU) Strategy on Adaptation to Climate Change in 2021. The strategy outlines how the EU can adapt to the inevitable impacts of climate change and achieve climate neutrality by 2050

Albania has continued its efforts to address climate change adaptation through national and sectoral plans and strategies, legislation, and management plans. Some of these include the National Strategy for Development and Integration 2015-2020, the Intersectoral Environmental Strategy 2015-2020, the Strategic Policy Document for Biodiversity Protection for the period 2016-2020, the National Strategy for Integrated Water Resources Management, the National Climate Change Strategy and Plan, the National General Plan 2030, and the Integrated Intersectoral Plan for the Coastline. These strategies aim to strengthen the country's capacity to manage the impacts of climate change and take measures to ensure that Albania is better prepared for future environmental challenges.

The investments made so far by the Albanian state in this area have been negligible, and the problems stemming from their lack were also highlighted by observations from foreign tourists. Proper management of the extraordinary potential that Albania holds in this regard requires clear policies focused on sustainability and longevity. This is crucial, considering the benefits that come from urgent investments in technical staff, infrastructure, and increasing funds for this purpose. These investments should be viewed not only from a short-term perspective but more importantly, in terms of preserving this fragile heritage for future generations.

The goal of state and broader policies is to continue this tradition, ensuring preservation in its original form, structure, and composition, or to invest in creating expert teams for restoration where needed or for further excavation at sites with prehistoric history and culture.

weather conditions and spreading economic benefits across different regions. Effective policies and strategic planning are necessary to address climate change challenges. Government and industry collaboration is key to developing and enforcing these policies. Mitigating health risks related to climate change is essential for protecting tourists and residents. Measures such as improved healthcare services, early warning systems for extreme weather, and public education on health risks can enhance safety and well-being.

By adopting these strategies, Albania can effectively address the impacts of climate change on its tourism industry. Ensuring resilience, sustainability, and diversification will safeguard the sector, contributing to the country's economic development and preserving its natural and cultural assets for future generations

The engagement of society and governments in changing these attitudes is crucial for successful climate change efforts. The analysis shows that citizens are more concerned about the poor standard of living and the prevailing poverty in the country, with nearly four out of ten citizens worried about this issue.

Mitigation policies aimed at reducing greenhouse gas emissions will raise transportation costs and could impact tourist travel patterns. Despite the challenges posed by climate change, tourism in the region is expected to continue growing.

Albania has opportunities to manage its vulnerability to weather and climate. There are several important measures that Albania can take today to support the optimal use of energy, water resources, and hydroelectric activities. Taking these steps now will help Albania better manage climate fluctuations and create the possibility for the country to be more resilient to climate change in the future.

Improving how institutions monitor, forecast, and disseminate information on meteorological and hydrometeorological conditions. Improving energy efficiency by reducing losses in the system, encouraging and assisting consumers to manage their demand for electricity. Ensuring the management and development of water resources by integrating all sectors: energy, agriculture, water supply, and sewage, as well as cross-border issues, while taking into account environmental and social issues.

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COMMUNITY AWARENESS FOR CLIMATE CHANGE IN ALBANIA

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BACKGROUND: Climate change is significantly impacting health through frequent extreme weather events, leading to death and illness. This intervention aimed to increase community awareness and knowledge about climate change and its socioeconomic and health consequences.

METHODOLOGY: From January to March 2024, information sessions were organized in seven districts, targeting both urban and rural areas. Facilitated by public health experts and local government representatives, these sessions aimed to deepen community understanding of climate change and its impacts.

RESULTS: Twenty-one informative sessions were conducted, engaging 451 community members and professionals across seven districts in Albania. Additionally, three significant community events were held with the participation of Mayors in Gramsh, Librazhd, and Belsh. The sessions highlighted the impact of climate change on water availability and quality, especially in rural and suburban areas such as Korça, Elbasan, Peqin, Kukës, and Lezha. Discussions focused on the health impacts of climate change, including increased water-borne diseases, heat-related illnesses, and respiratory problems, signaling public health concerns. Participants were educated on efficient and sustainable water use and how to prepare for and respond to climate-related emergencies, promoting resilience and proactive measures.

CONCLUSIONS: The informative sessions successfully cultivated a collaborative environment, empowering community members to take proactive measures against climate change. By fostering local, community-driven strategies, these sessions not only enhanced awareness but also equipped

participants with practical knowledge to adapt and respond effectively to climate-related challenges. This intervention demonstrated the potential of community engagement in building resilience and promoting sustainable practices to mitigate the adverse effects of climate change.

Keywords: climate change, community awareness, public health experts, Albania

LOGISTICAL PERFORMANCE AND ECONOMIC VIABILITY OF LOCAL PRODUCT COOPERATIVES IN MOROCCO

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Abstract

Cooperative enterprises offer a significant economic and social alternative to meet the population's needs. Their global emergence and development largely result from increased awareness of the importance of cooperation for economic inclusion and sustainable development. In Morocco, cooperatives operate in various sectors, including the production and valorization of local products and the provision of services.

In the era of new logistical techniques, these organizations must adapt to market trends. This adaptation requires efforts to equip cooperatives and their members with appropriate tools while strengthening their digital capabilities.

This document aims to address three main questions:

1. What is the logistical performance of local product cooperatives in Morocco?
2. How do new methods improve the economic viability of local product cooperatives while maintaining their commitment to social and local development?
3. What are the potential challenges related to integrating new methods into local product cooperatives, and how can they be overcome?

To answer these questions, we conducted a literature review to contextualize our subject and propose a solid conceptual framework. We then explored how new techniques can benefit local product cooperatives, drawing on theoretical contributions and previous writings. These insights were supplemented by a case study of a local product cooperative, which confirmed certain findings through practical steps in the supply chain. Finally, we identified the challenges and issues related to this integration and proposed solutions to overcome them.

Keywords: Cooperative enterprises, Economic inclusion, Local products, Logistical performance, Sustainable development.

**CARBON NANOHORNS – BASED MATERIALS AS PROMISING SORBENTS FOR
EFFICIENT REMOVAL OF VARIOUS CONTAMINANTS FROM WATER**

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Abstract

In the last years, carbon nanohorns (carbon nanostructures consisting of sp^2 hybridized carbon atoms that form a conical molecular of 2–5 nm in diameter and 30–50 nm in length) have gained increased attention for several applications thanks to their outstanding characteristics such as clean synthesis methods, large specific surface area, availability of high-purity samples, thermal stability, good electrical conductivity, low toxicity, high porosity. Thus, both pristine and functionalized carbon nanohorns and their nanocomposites/nanohybrids were used in various fields such as energy conversion, applied electrochemistry, gas sensing, gas storage, and biomedicine.

This paper outlines the recent progress regarding the utilization of carbon nanohorns for environmental remediation purposes. CNHs can effectively remove pollutants, such as heavy metals, volatile organic compounds, and polycyclic aromatic hydrocarbons, from water and air.

The following topics are detailed in the paper:

- improved uranium (VI) removal from water using SWCNH–COOH and SWCNH–TETA (triethylenetetramine) as sorbents;

- polyvinylidene difluoride - carbon nanohorn hybrid membranes for efficient removal of methyl acetate and ethanol from water;
- dispersive micro solid-phase extraction of triazines from waters using oxidized single-walled carbon nanohorns as sorbent;
- carbon nanohorns immobilized on a microporous hollow polypropylene fiber as a sorbent for the extraction of volatile organic compounds from water samples;
- carbon nanohorns-based hybrid for extraction of polycyclic aromatic hydrocarbons and nonsteroidal anti-inflammatory drugs in water and biological samples.

All the applications are analyzed from the perspective of thermodynamic parameters, adsorption time, initial concentration of analyte, recycling performance, and selectivity

Keywords: environmental remediation, carbon nanohorns, sorbent, membrane

**REPLACING SYNTHETIC FERTILIZER USING GOAT MANURE IN SORGHUM
(*Sorghum bicolor* L.) CULTIVATION**

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Abstract

Sorghum has the potential to be an alternative food source in Indonesia, but its growth depends heavily on soil fertility. The excessive use of synthetic fertilizers is detrimental to the soil and environment. Hence, the integration of organic fertilizers, particularly goat manure, is necessary to avoid soil degradation. This research aimed to determine the optimal dose of goat manure to substitute synthetic fertilizer for sorghum productivity. The study took place in Kemumu Village, Arma Jaya District, North Bengkulu Regency, Bengkulu, Indonesia, employing Complete Randomized Block Design (CRBD) with the following treatments: no fertilizer (control), Urea (200 kg/ha), TSP (150 kg/ha), KCl (200 kg/ha), goat manure (20 tons/ha), a combination of synthetic fertilizer (150 kg/ha urea, 112.5 kg/ha TSP, and 50 kg/ha KCl) + goat manure (5 ton/ha), synthetic fertilizer (100 kg/ha urea, 75 kg/ha TSP, and 100 kg/ha KCl) + goat manure (10 ton/ha), and synthetic fertilizer (50 kg/ha urea, 37.5 kg/ha TSP, and 50 kg/ha KCl) + goat manure (15 ton/ha). The results indicated that sorghum fertilized with goat manure, synthetic fertilizer, or a combination of both exhibited better growth and yields compared to unfertilized plants. Various combinations of synthetic fertilizer and goat manure resulted in comparable growth and yields to those with the recommended dose of synthetic fertilizer alone. These findings suggest that using goat manure can reduce the reliance on synthetic fertilizers for sorghum cultivation, promoting sustainable agriculture.

Keywords: Sorghum cultivation, Goat manure, Soil fertility, Synthetic fertilizer substitution, Sustainable agriculture

INTRODUCTION

The increasing awareness of sustainable agricultural practices has prompted a reevaluation of traditional farming inputs, particularly the use of synthetic fertilizers. While synthetic fertilizers have been effective in boosting crop yields, their long-term impact on soil health, environmental quality, and ecosystem balance has raised concerns (Tripathi et al., 2020). As a result, there is growing interest in using organic fertilizer that can provide the necessary nutrients while enhancing soil structure and fertility (Ye et al., 2020; Liu et al., 2021)

Among organic fertilizers, goat manure stands out as a promising organic fertilizer due to its nutrient-rich composition and potential to improve soil health. Goat manure is a valuable organic resource, rich in essential nutrients such as nitrogen, phosphorus, and potassium, which are crucial for the growth and development of crops like sorghum (*Sorghum bicolor* L.) (González et al., 2023).

The nutrient content of manure varies depending on the type of livestock, which is influenced by the feed and age of the animals. For example, cow manure contains N 2.33%, P₂O₅ 0.61%, K₂O 1.58%, Ca 1.04%, Mg 0.33%, Mn 179 ppm, and Zn 70.5 ppm; chicken manure contains N 3.21%, P₂O₅ 3.21%, K₂O 1.57%, Ca 1.57%, Mg 1.44%, Mn 250 ppm, and Zn 315 ppm; cricket manure has N 3.80%, P₂O₅ 2.30%, K₂O 2.70%, Ca 2.00%, Mg 0.66%, Mn 197 ppm, and Zn 506 ppm; and goat manure contains N 2.10%, P₂O₅ 0.66%, K₂O 1.97%, Ca 1.64%, Mg 0.60%, Mn 233 ppm, and Zn 90.8 ppm. Despite the variations, all types of manure are beneficial for sorghum as long as fully decomposed (Hartati et al., 2022).

The slow-release nature of these nutrients from organic matter can lead to more sustained plant growth and reduce the risk of nutrient leaching, a common issue with synthetic fertilizers (Wang et al., 2022; Shaji et al., 2021). Furthermore, the organic matter in goat manure can improve soil structure, increase water retention, and enhance microbial activity, all of which contribute to healthier and more resilient crops such as sorghum (*Sorghum bicolor*, L.) (Haridha et al., 2020).

Sorghum is a versatile and drought-tolerant crop widely cultivated in various parts of the world for food, fodder, and biofuel production (Hossain et al., 2022). Sorghum holds great potential as an alternative food source in Indonesia as well. Sorghum relies considerably on soil fertility, which is frequently enriched with synthetic fertilizers. The unwise and long-term use of synthetic fertilizers has negative impacts on the environment, including soil. Therefore, the use of organic fertilizers can be considered as an alternative to replace synthetic fertilizers in sorghum cultivation. However, the effects of replacing synthetic fertilizers with goat manure on sorghum cultivation have not been extensively studied. Understanding the impact of goat manure on sorghum growth, yield, and soil health is essential for developing sustainable agricultural practices that can benefit both farmers and the environment. Research is needed to explore the effects of combining synthetic and organic fertilizers on sorghum growth. This study aimed to investigate the potential of goat manure as an alternative to synthetic fertilizers in sorghum cultivation.

RESEARCH AND FINDINGS

METHODOLOGY

Location and Research Design

This research was carried out from September to December 2022, in Kemumu Village, Arma Jaya District, North Bengkulu Regency, Indonesia using a Complete Randomized Block Design (RAKL) design with 3 replications. The treatments were:

P₀= no fertilizer (control)

P₁: Urea (200 kg/ha), TSP (150 kg/ha), KCl (200 kg/ha)

P₂: Goat manure 20 ton/ha

P₃: 75% P₁ + 25% P₂

P₄: 50% P₁ + 50% P₂

P₅: 25% P₁ + 75% P₂

Experimental Procedure

Sorghum of the Numbu variety was planted using direct seeding with a spacing of 75 cm x 25 cm. Goat manure was applied one week before planting by homogeneously spreading it over the soil surface. Synthetic fertilizers containing N, P, and K were applied at planting. Nitrogen was applied twice: half at planting and the remaining two weeks after planting (WAP). The fertilizer was placed around the planting holes. A fungicide with Xemium + Pyraclostrobin at a concentration of 75 ml per liter of water was applied to prevent infestation of diseases. Weed was manually controlled at 2, 4, and 6 WAP.

The plant was watered regularly to maintain the soil moisture and ensure sufficient water for plant growth unless there was rain. Harvesting took place when the sorghum grains reached physiological maturity, indicated by the grain had reached full size and turned brown. The plant was pulled up using hoe, then removing the soil from the roots and separating the roots, stems, and panicles. Variables observed included plant height (cm), stem diameter (mm), number of leaves (leaves/plant), leaf area (cm²/plant), fresh shoot weight (g/plant), dry shoot weight (g/plant), fresh root weight (g/plant), dry root weight (g/plant), panicle weight per plant (g/plant), panicle weight per plot (g/plot), shoot-root ratio, and number of stomata.

Data Analysis

The collected data was analyzed using Analysis of Variance (ANOVA) at a 5% significance level. The treatment mean was further compared using the Least Significant Difference (LSD) test.

RESULT and DISCUSSION

Variance Analysis Results

The analysis of variance results indicated that the fertilization treatment significantly affected plant height, stem diameter, leaf area, shoot dry weight, and panicle weight per plot. However, the treatment did not significantly influence the number of leaves, fresh shoot weight,

fresh root weight, dry root weight, shoot-to-root ratio, number of stomata, fresh panicle weight per plant, panicle length, or the weight of 100 seeds (Table 1).

Table 1. Summary of Variance Analysis

Variabel Pengamatan	F-calc	CV (%)
Plant height	3.42*	5.91
Stem diameter	3.78*	7.70
Leaves number	2.83 ^{ns}	3.82
Leaves area	4.05*	6.25
Shoot fresh weight	0.72 ^{ns}	11.13
Shoot dry weight	3.91*	11.21
Root fresh weight	2.79 ^{ns}	15.74
Root dry weight	0.39 ^{ns}	23.11
Shoot Root Ratio	1.47 ^{ns}	15.56
Number of Stomata	0.42 ^{ns}	6.22
Panicle weight/plant	1.85 ^{ns}	11.81
Panicle weight/plot	7.42*	8.59
Panicle length	0.29 ^{ns}	3.89
Weight of 100 Seeds	0.51 ^{ns}	7.37

Note: * = significantly different, ^{ns} = non significantly different; F-tab 5% = 3,33, CV = coefficient variation

Plant Growth Components

The application of synthetic fertilizer, goat manure, or a combination of both resulted in taller sorghum plants, with more leaves and larger stem diameters compared to the control (no fertilizer). Fertilizer application increases plant growth by supplying essential nutrients, such as nitrogen, phosphorus, and potassium, which are often limited in the soil. These nutrients are crucial for vital physiological processes, including photosynthesis, energy transfer, and protein synthesis, which collectively enhance cell division, root development, and overall biomass production, leading to more vigorous and robust plant growth.

There were no significant differences in sorghum growth across fertilizer treatments (P₁-P₅). This result suggests that the different combinations of synthetic and organic fertilizers, as well as the use of goat manure alone, have a similar effect on the growth of sorghum. Therefore, both synthetic fertilizers and goat manure, whether used alone or in various proportions, provide similar benefits for sorghum cultivation.

Table 2. Effect of treatment on sorghum plant growth

Treatments	Plant height (cm)	Stem diameter (mm)	Leaves area (cm ²)	Leaves number	Stomata number
P ₀	157.48 b	16.50 b	470.15 b	8.53	13.07
P ₁	175.67 ab	19.11 ab	552.86 a	8.93	12.87
P ₂	178.59 a	21.11 a	564.87 a	9.07	12.67
P ₃	189.93 a	20.95 a	569.39 a	9.53	13.40
P ₄	183.27 a	20.23 a	578.13 a	9.27	12.73
P ₅	171.47 ab	19.59 a	563.57 a	9.00	12.60

Note: Numbers followed by the same letter in the same column are not significantly different in the BNT α test at the 5% level. P₀ (no fertilizer/control), P₁: Urea (200 kg/ha), TSP (150 kg/ha), KCl (200 kg/ha), P₂: Goat manure 20 ton/ha P₃: 75% P₁ + 25% P₂, P₄: 50% P₁ + 50% P₂, P₅: 25% P₁ + 75% P₂

Goat manure application yielded similar plant height, stem diameter, and leaf area as synthetic fertilizers. Similar plant growth indicates that goat manure can supply nutrients to plants as effectively as synthetic fertilizers. Muis et al. (2018) reported that organic fertilizers can match the effectiveness of synthetic fertilizers in promoting sorghum growth.

The study also revealed no significant differences in the number of leaves and stomata among treatments receiving synthetic fertilizer, goat manure, or a combination of both. The nonsignificant difference may be related to the fact that leaf number is largely influenced by genetic factors (Dewi et al., 2023). Additionally, no significant differences were observed among treatments on shoot fresh weight, root fresh weight, root dry weight, and shoot-to-root ratio, and significant differences in shoot dry weight (Table 3).

Table 3. Effect of treatment on shoot fresh weight, shoot dry weight, weight fresh roots, dry weight of roots and shoot root ratio

Treatments	Shoot fresh weight (g)	Shoot dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Shoot Root Ratio
P ₀	292.87	62.85 b	52.13	17.66	3.61
P ₁	314.53	57.09 b	71.13	16.83	3.44
P ₂	336.47	63.74 b	58.20	15.35	4.29
P ₃	317.33	57.86 b	79.80	14.43	4.06
P ₄	338.27	66.35 b	66.07	17.88	3.86
P ₅	334.27	79.88 a	61.27	17.37	4.61

Note: Numbers followed by the same letter in the same column are not significantly different in the BNT α test at the 5% level. P₀ (no fertilizer/control), P₁: Urea (200 kg/ha), TSP (150 kg/ha), KCl (200 kg/ha), P₂: Goat manure 20 ton/ha P₃: 75% P₁ + 25% P₂, P₄: 50% P₁ + 50% P₂, P₅: 25% P₁ + 75% P₂

Treatment P₅ (50 kg/ha urea + 37.5 kg/ha TSP + 50 kg/ha KCl + 15 tons/ha goat manure) resulted in the highest shoot dry weight, which was significantly greater than that of the other treatments. In contrast, treatments P₀, P₁, P₂, P₃, and P₄ did not have significant differences in shoot dry weight (Table 3). This result suggests that the nitrogen availability in treatment P₅ is more available to plant growth compared to the other treatments. A previous study confirmed that the application of goat manure to the soil enhanced overall soil nitrogen availability (Sarbaina et al., 2021). Another study

indicated that increased nitrogen uptake by plants contributes to the greater dry weight of sorghum stover (Farah et al., 2018). Additionally, substituting goat manure for up to 75% of synthetic fertilizer has been reported to boost the dry weight of corn stover (Nugroho et al., 2022).

Crop yield component

Substitution of synthetic fertilizer with goat manure up to 100% produces panicle weight per plot as good as 100% synthetic fertilizer. This result is in line with the study by Purba et al. (2022) where the yield of sorghum in organic and synthetic fertilizer treatments was not significantly different.

Table 4. Effect of treatment on sorghum crop yield

Treatments	Panicle weight/plant (g/plant)	Panicle weight/plot (g/plot)	Plant productivity (ton/ha)	Panicle length (cm)	Weight of 100 seeds (g)
P ₀	86.40	587.67 b	1.31	21.72	46.00
P ₁	104.93	818.00 a	1.82	21.39	46.67
P ₂	100.40	772.00 a	1.72	21.45	45.33
P ₃	108.73	810.33 a	1.80	21.99	43.33
P ₄	114.60	851.33 a	1.89	21.96	47.33
P ₅	106.07	892.67 a	1.98	21.52	45.33

Note: Numbers followed by the same letter in the same column are not significantly different in the BNT α test at the 5% level. P₁: Urea (200 kg/ha). TSP (150 kg/ha). KCl (200 kg/ha). P₂: Goat manure 20 ton/ha P₃: 75% P₁ + 25% P₂. P₄: 50% P₁ + 50% P₂. P₅: 25% P₁ + 75% P₂

Organic fertilizer can increase the availability of nutrients in the soil. Increased organic material in the soil will also increase nutrient availability (Ganti et al., 2023). Applying manure can provide various benefits, including increased soil chemical properties such as soil pH, Cation Exchange Capacity (CEC), organic C, and the availability of N, P, and K (Trisnady et al., 2018). The addition of manure is reported to improve soil physical properties, especially bulk density, soil aggregate, water content, field capacity, and porosity (Ramli et al., 2016). Increasing soil fertility will increase sorghum yields. Kolo's (2021) reported that the application of goat manure can increase the yield of sorghum plants.

The study indicated that providing synthetic and organic fertilizers was able to increase panicle weight per plant, panicle weight per plot, and sorghum productivity compared to the control. An increase in panicle weight per plant and weight of 100 seeds compared to the control was produced by the P₄ treatment. An increase in panicle weight per plot and the highest productivity resulted from the P₅ treatment.

Providing synthetic and organic fertilizers can increase nutrient availability for plants, especially N, P, and K, so that sorghum yields increase compared to control. Nutrients are essential to form proteins, carbohydrates, and amino acids as important compounds in stimulating further seed development and the higher the protein. The formation of carbohydrates and amino acids will increase seed weight due to the high levels of these compounds in the seeds (Zubaidi et al., 2021).

Plant requires a larger amount of N compared to other plant nutrients (Suminarti, 2019) and in plants, this nutrient has an important role as a constituent of chlorophyll, which plays a role in the process of plant photosynthesis, and the formation of proteins and DNA. Therefore, it is necessary

to provide N fertilizer in sufficient and balanced conditions (Pradana et al., 2015). In low availability of N, plants will show symptoms of chlorosis, characterized by yellowing of the old leaves, decreased photosynthesis rate, and low assimilate production. On the other hand, in high N availability, plants are succulent, easily attacked by pests and diseases, lengthen the vegetative phase, and reduce plant yields because the plant's generative phase is shorter (Mohamed et al., 2019). Also, plant yields are dependent on plant growth components, where better plant growth will lead to better crop yield (Razaek et al., 2021).

In addition, P plays a role in accelerating fruit formation in generative growth. The nutrient is important as energy in various metabolic activities, such as photosynthesis and plant respiration (Basri et al., 2015). Providing P fertilizer has been reported to increase the yield of sorghum plants (Suminar et al., 2017) and corn plants (Puspitasari et al., 2018).

CONCLUSIONS

Sorghum fertilized with goat manure and a combination of synthetic fertilizers exhibited comparable growth and yields to synthetic fertilizers. Sorghum fertilized with goat manure and a combination of fertilizers as well as sole synthetic fertilizer showed higher plant productivity compared to those not fertilized (control). These findings suggest that goat manure can substitute synthetic fertilizer, decreasing its use for sorghum cultivation. Sustainable agriculture can be attained using the substitution of synthetic fertilizer with goat manure or other animal dung.

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**THE IMPORTANCE OF BUILDING DOG PARKS (ECO ZONES) IN DECREASE
POLLUTION OF PUBLIC PLACES WITH DOG FACES AND PARASITS**

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Abstract

Pets, especially dogs, play a significant role in the lives of modern people, especially in the urban environment. In an urban environment such as Belgrade, green areas and parks are the main place where children play and are resting places for city people, but they are also places where dog owners take their pets out. During their stay in these areas, dogs defecate on them, and apart from their unpleasant appearance and smell, dog excrement represents a kind of epidemiological danger, considering that dogs are carriers and real hosts of a large number of species of zoonotic parasites. In order to monitor the parasitic contamination of parks and other green areas of Belgrade, since 1993, continuous monitoring of their pollution has been carried out. Over time, those researches led to the introduction of a large number of measures that contributed to reducing the contamination of these spaces with parasite eggs. In the period 2008 - 2011, visual instructions, notices and markings were made for areas designated for off-leash dogs as well as where dogs are not allowed. In the same period, a system of baskets with PVC bags for the disposal of dog feces (doggy-pot system) was created, and since 2011, eco zones or dog parks have been formed in some parks. A special segment in Belgrade has been the adoption of problem-solving strategies in the city of Belgrade for stray dogs and cats, which was adopted at the Belgrade City Assembly held 2011. In the period 2012-2022, the trend of building dog parks within city parks continued, the education program on responsible ownership and landscaping of public areas continued. Based on the performed parasitological control of soil contamination from parks, the presence of parasite eggs was found to be over 40% less than in the period 2001-2011.

Key words: dogs, pollution, public places, dog parks, Belgrade

**THE ROLE OF ART AS A SOLUTION PARTNER IN THE FIGHT AGAINST CLIMATE
CHANGE**

**SANATIN İKLİM DEĞİŞİKLİĞİ MÜCADELESİNDE BİR ÇÖZÜM ORTAĞI OLARAK
ROLÜ**

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ÖZET

Çevre sorunları özellikle geçen yüzyılın ikinci yarısından itibaren dünya gündemini işgal eden en önemli sorunlardan biri olmuştur. Bilimsel araştırmalar, politika önerileri ve teknolojik yenilikler, bu küresel sorunun üstesinden gelmek için kritik öneme sahip olsa da, sanatın da bu mücadelenin önemli bir parçası olduğu giderek daha fazla kabul görmektedir. Sanat, sadece insanlara bu krizin boyutlarını ve sonuçlarını anlatmakla kalmaz, aynı zamanda duyarlılık yaratır, farkındalığı artırır ve toplumsal değişim için bir katalizör görevi görebilir. Çevre olaylarına duyarlı sanatsal üretim biçimleri 1970'lerde Yeryüzü Sanatı ile ortaya çıkmış, sonrasında çeşitlenerek odağına doğayı ve çevre bilincini yerleştiren Çevre Sanatı, Doğa Sanatı, Ekolojik Sanat gibi yeni pratiklerle devam etmiştir. Günümüzde tüm dünyada Ekolojik sorunlar sanat ortamlarının da başat konularından biri haline gelmiş özellikle de günümüzde plastik kirliliği ve iklim değişikliği sanatçıların bu alandaki üretimlerini tetikleyen meseleler olmuştur.

Bu çalışmada, sanatın iklim değişikliği mücadelesindeki yeri güncel sanat örnekleri üzerinden incelenecektir.

Anahtar Kelimeler: Ekolojik Kriz, Güncel Sanat, Çevresel Sanat

Abstract

Environmental issues have been one of the most important issues occupying the world agenda, especially since the second half of the last century. While scientific research, policy proposals and technological innovations are of critical importance to overcome this global problem, it is increasingly accepted that art is also an important part of this struggle. Art not only tells people about the dimensions and consequences of this crisis, but also creates sensitivity, raises awareness and can act as a catalyst for social change. Artistic production forms sensitive to environmental events emerged with Earth Art in the 1970s, and later diversified and continued with new practices such as Environmental Art, Nature Art and Ecological Art, which place nature and environmental awareness at their center. Today, ecological issues have become one of the leading topics in art circles all over the world, and especially today, plastic pollution and climate change have become issues that trigger artists' production in this field.

In this research, the place of art in the struggle for climate change will be examined through examples of contemporary art.

Keywords: Ecological Crisis, Contemporary Art, Environmental Art

GİRİŞ

İklim deęişikliği, insanlığın karşı karşıya olduęu en büyük zorluklardan biridir. Bilimsel arařtırmalar, politika önerileri ve teknolojik yenilikler, bu küresel sorunun üstesinden gelmek için kritik öneme sahip olsa da sanatın da bu mücadelenin önemli bir parçası olduęu giderek daha fazla kabul görmektedir. Sanat, sadece insanlara bu krizin boyutlarını ve sonuçlarını anlatmakla kalmaz, aynı zamanda duyarlılık yaratır, farkındalığı artırır ve toplumsal deęişim için bir katalizör görevi görebilir. Özellikle iklim krizi gibi acil ve karmaşık sorunlar karşısında, sanatçılar, eserleri aracılığıyla bu krizlere dair eleştirel bir bakış açısı sunmakta ve izleyicileri eyleme geçmeye teşvik etmektedir.

Çevre sorunları özellikle geçen yüzyılın ikinci yarısından itibaren dünya gündemini işgal eden en önemli sorunlardan biri olmuştur. Sanayileşme, şehirleşme ve nüfus artışı ile tüketim alışkanlıklarındaki deęişim; hava kirlilięi, su kirlilięi, toprak kirlilięi gibi gezegenimizin sınırlarını zorlayan olumsuz etkilere sebep olmuştur. Ekolojik kriz, sanatın içerięine doğrudan yansımış, birçok sanatçı çevresel sorunları eserlerinin ana teması haline getirmiştir. Bu tematik yansımalar, doğrudan çevresel yıkım, biyolojik çeşitliliğin kaybı, iklim deęişikliği ve doğa-insan ilişkisinin bozulması gibi konuları ele alır. Sanatçılar, bu konuları işleyerek izleyicilerin dikkatini çevresel problemlere çekmeye çalışır ve onları harekete geçmeye teşvik eder.

İçinde yaşadığımız dünyanın yeni bir jeolojik çaęa girdięi düşünülmektedir. Antroposen adı verilen bu yeni çaęın en belirgin özellięi ise, ona jeolojik faaliyetlerden ziyade insan faaliyetlerinin yol açmış olmasıdır. İnsanın, yeryüzünü paylaştığı dięer biyolojik türlerden kendini üstün görerek, kendisini yaşadığı gezegeni küresel anlamda çoęu zaman geri döndürülemez biçimde deęiştirme kapasitesine sahip bir güç olarak konumlandırması bu çaęa “insan çaęı” denmesinin nedenidir. Temelde Antroposen kavramıyla iddia edilen şey, insanın teknolojinin de yardımıyla, çevresel süreçlere müdahale ederek ve onların doğasını deęiştirecek kadar etkin bir güç, Yerküreyi paylaştığı dięer biyolojik türlerin de hayatını etkileyecek kadar baskın bir tür, küresel kapsamdaki çevresel deęişikliklerin belirleyicisi bir baş aktör haline dönüşmüş olduğudur (Aykanat, 2017; 2). Antroposen’de gezegenin insan eli deęmemiş köşeleri gitgide azalırken, yerleşim merkezleriyle dięer canlıların paylaştığı kırsal arasında var olduğuna inanılan kültür-doęa ayrımı da ortadan kalkmıştır. Merkezine insanı koyarak kendi yaşantısı için doğaya hükmeden insanın ayrıcalıklı sayıldığı Antroposen ile umarsızca gezegenimizin kaynakları tüketilmekte ve insan faaliyetleri nedeniyle doğaya yönelik tahribat etkisini giderek daha belirgin şekilde göstermektedir.

Eylül 2019’da Birleşmiş Milletler Genel kurul toplantısında genç çevre aktivisti Greta Thunberg’in How Dare You başlıklı tarihi konuşması, basında geniş yer tutmuş ve bu yolla gezegenin geleceęi için iklim krizine farkındalık yaratmak amacıyla polikacı ve yasa koyuculara seslenmiş, herkesi mücadeleye çağırmıştır. Ekolojik tahribat ve küresel iklim deęişikliği aslında çok uzun süredir özellikle bu konuda arařtırma yapan insanların radarında olan konulardan biridir fakat durumun aciliyetiyle paralel olarak giderek artmış ve daha geniş kitlelere de ulaşmıştır.

Bu çağrılar toplumun birçok kesiminde olduğu gibi güncel sanatta da karşılığını bulmuş, dünyanın birçok yerinde güncel sanatta doğaya dikkat çeken, iklim krizine ve ekolojik olaylara odaklanan sayısız iş üretilmiştir. Tüm dünyada Ekolojik sorunlar sanat ortamlarının da başat konularından biri haline gelmiş özellikle de günümüzde plastik kirlilięi ve iklim deęişikliği sanatçıların bu alandaki üretimlerini tetikleyen meseleler olmuştur.

Sanatta Doğa Yansımaları

Doğa, çok eski zamanlardan beri sanatçılar için bir ilham kaynağı olmuştur. Antik çağlardan itibaren doğa, mitolojik ve dinsel anlatılarda kutsal bir unsur olarak ele alınmıştır. Doğa, tanrıların gücünü yansıtan bir alan olarak görülmüş ve insan-doğa ilişkisi bu kutsal bağlamda yorumlanmıştır. Örneğin, Yunan mitolojisinde doğa tanrıları, doğanın insan hayatı üzerindeki etkisini simgelerken, doğa olayları tanrısal iradenin göstergesi olarak kabul edilmiştir. Rönesans döneminde, doğa sanatta daha çok bir arka plan olarak yer alırken, insanın güzelliği ve mükemmelliği doğa ile birlikte yüceltilmiştir. Doğa, idealize edilmiş bir dünya olarak resmedilmiş, bu idealizasyon insanın doğa üzerindeki egemenliği ve uyumu ile ilişkilendirilmiştir. Bu dönemde sanatçılar, doğayı mükemmel bir şekilde temsil etmek için perspektif, ışık-gölge ve anatomi gibi teknikleri geliştirmişlerdir. Leonardo da Vinci'nin eserleri, insan ve doğa arasındaki bu mükemmel uyumu yansıtır. 18. yüzyıl sonu ve 19. yüzyıl başlarında ortaya çıkan Romantizm, doğaya karşı duyulan hayranlık ve insanın doğa karşısındaki küçüklüğü temalarını ön plana çıkarmıştır. Romantik sanatçılar, doğayı vahşi, güçlü ve bazen de ürkütücü bir güç olarak resmetmişlerdir. Bu dönemde doğa, insanın üzerinde kontrol sahibi olmadığı bir güç olarak görülmüş ve insanın duygusal durumları ile doğanın büyüklüğü arasında bir bağ kurulmuştur. Caspar David Friedrich'in manzara resimleri, bu temayı açıkça gözler önüne serer. Sanayi Devrimi ile birlikte, doğa ve insan arasındaki ilişki, doğanın yıkımı ve çevresel bozulma bağlamında ele alınmaya başlamıştır. Bu dönemde sanatçılar, endüstrileşmenin doğa üzerindeki olumsuz etkilerini resimlerinde ve heykellerinde işlemişlerdir. 20. yüzyılda modernist sanatçılar, insan-doğa ilişkisini daha soyut ve kavramsal bir şekilde ele almışlardır. Doğa, sanatın biçimsel ve kavramsal bir unsuru haline gelmiş, insanın doğayla ilişkisi yeni sanatsal ifade biçimleriyle yorumlanmıştır. Modernist sanatçılar, doğayı bazen bir metafor, bazen de bir deney alanı olarak kullanmışlardır.

Ancak son yıllarda, yangınların, kasırgaların, sellerin ve sıcak dalgalarının neredeyse günlük tecrübe edildiği bir dünyada ekolojik krizin etkileri çok daha fazla hissedilmeye başlamış, içinde bulunduğumuz ekolojik kriz hem yerel hem küresel olarak en yaşamsal sorunlardan biri haline gelmiştir. Bu da doğayı bir unsur olarak sanatın konusu haline getirmekten öteye taşımış çevre olaylarına duyarlı sanatsal üretim biçimleri 1970'lerden günümüze farklı biçimlerde sanat tarihsel süreçte sıkça karşımıza çıkmaktadır. Yeryüzü Sanatı, Çevre Sanatı, Doğa Sanatı, Ekolojik Sanat gibi akımlarla çevresel sorunlar da sanatın konusu haline gelmiştir. Pek çok ülkede hükümetlerin 1970'li yıllarda başlayıp genişletilerek uygulamaya giriştiği çevre politikalarına ve uluslararası alanda yürürlüğe konulan önlemlere karşın, ekolojik sorunlar çözülme bir yana yoğunlaşarak sürmektedir (Keleş, 1993: 29).

Günümüzde, insan-doğa ilişkisi, ekolojik krizler ve sürdürülebilirlik bağlamında sıkça ele alınmaya başlamış, sanatçılar çevresel sorunları gündeme getiren eserler üreterek, insanın doğa üzerindeki etkilerini sorgular ve doğanın korunması için çağrılarda bulunan işler üretmeye başlamışlardır.

Güncel Sanat ve Ekoloji kitabının yazarı Andrew Brown'ın kitabın girişinde bahsettiği gibi;

Bugünlerde bir galeriye veya müzeye girip ya da bir sanat dergisi veya internet sitesine göz atıp da bir şekilde doğal dünyayla ilişkili olan bir sanat eseriyle karşılaşmamak neredeyse imkansız. Bir zamanlar sadece küçük bir grubun ilgilendiği çevre sorunlarına eğilen sanat pratikleri, son beş yıl içinde sanat alanının ana akımlarından biri haline geldi. Çevre ile ilgili ciddi sorular gündeme getiren sanat, kıyıda kenarda olmaktan çoktan çıkmış, sahnenin merkezinde yerini almış, hem daha geniş çevrelerin katıldığı tartışmalara yanıt vermekte hem de bu tartışmaları şekillendirmektedir (Brown, 2014, 6). Günümüzde doğa-insan ilişkisinin insanın evrensel var oluşunda ne denli önemli olduğu bilgisi sanat ortamını, sanatçıları harekete geçirmiş sanat bir bakıma bu yolda aracı tayin edilmiştir.

Sanatın toplum üzerindeki etkisi yüzyıllardır kabul görmektedir. Toplumun duyarlılığını artırmak, insanları harekete geçirmek ve sosyal değişim için zemin hazırlamak sanatın tarihsel olarak üstlendiği rollerdendir. Bu bağlamda, sanatın iklim değişikliği gibi küresel bir krizle mücadelede etkili bir araç olması şaşırtıcı değildir. Sanatın bu mücadeledeki rolü, genellikle görsel imgeler, performanslar, enstalasyonlar ve diğer sanatsal ifadeler aracılığıyla toplumsal farkındalık yaratmak şeklinde kendini gösterir.

Birçok sanatçı, ekolojik kriz konusunu ele alırken aynı zamanda aktivist bir tutum benimser. Bu sanatçılar, eserlerini birer protesto aracı olarak kullanır ve toplumsal değişim için çağrıda bulunur. Örneğin, çevresel bozulmayı ele alan büyük çaplı duvar resimleri veya kamuya açık alanlarda gerçekleştirilen performanslar, toplumsal bilinç oluşturmayı amaçlar. Ekolojik kriz, sanatçılar ve bilim insanları arasında yeni işbirliklerinin doğmasına da yol açmıştır. Bu disiplinlerarası anlayış ve yapılan işbirlikleri, bilimsel verilerin sanatsal yollarla yorumlanması ve geniş kitlelere aktarılması amacıyla gerçekleştirilir. Sanatçılar, bilimsel araştırmalarla desteklenen projeler üreterek, çevresel sorunların daha anlaşılır ve etkileyici bir şekilde sunulmasını sağlar.



Resim1. Mel Chin, Revival Field, 1990-1993

Sanatçı Mel Chin'in 1990-93 yılları arasında gerçekleştirdiği Revival Field adlı eseri, çevre kirliliğine karşı farkındalık yaratmak amacıyla oluşturulmuştur ve sanatı bilimle buluşturan en iyi örneklerden biridir. Bu proje, endüstriyel atıklarla kirlenmiş bir arazi üzerinde gerçekleştirilen bir biyoremediasyon çalışmasıdır. Bitkilerin ağır metalleri topraktan temizlemesi sürecini sanatsal bir yerleştirme olarak sunan bu eser, hem çevre bilincini artırır hem de sanat ve bilimin işbirliğini vurgular. Revival Field, bir alanın ekolojisini şekillendirmek amacıyla kavramsal bir sanat eseri olarak başlamıştır. 1993, bu işbirlikçi çabanın ilk aşamasının başarılı bir şekilde sona ermesini işaret eder. Minnesota, St. Paul'daki bir Eyalet Süperfonu sahası olan Pig's Eye Çöplüğü'nde bulunan ilk deney, kirlenmiş topraktan ağır metalleri çıkarmak için özel hiperakümülatör bitkileri kullanan tekrarlanmış bir saha testi ve bir yeşil iyileştirme projesidir.



Resim 2. Ellie Irons & Anne Percoco, The Next Epoch Seed Library, 2015-

Ellie Irons ve Anne Percoco'nun bu projesi, çevresel bozulmaya karşı dirençli olan "otlak bitkilerini" toplayarak saklamaya dayanmaktadır. Bu kütüphane, gelecekteki ekolojik krizlere ve iklim eşitsizliğine hazırlıklı olma amacı taşır. Sanatçılar, şehirleşme ve endüstriyel faaliyetler nedeniyle azalan biyolojik çeşitliliğe dikkat çekerek, çevre kirliliği ve habitat kaybı gibi konuları ele alırlar. Next Epoch Seed Library (NESL), yabani otlar olarak bilinen yeni, kendiliğinden oluşan ve uyum sağlayabilen bitkilere odaklanan, sanatçı tarafından yürütülen bir tohum tasarruf projesidir. 2015 yılında Ellie Irons ve Anne Percoco tarafından kurulan proje, yoğun insan popülasyonlarıyla yakın ilişki içinde yaşama eğiliminde olan bu bitkilerden tohum toplamaya, depolamaya ve paylaşmaya odaklanmaktadır. NESL, sunumlar, atölyeler, tohum takasları ve sergiler aracılığıyla izleyicileri ve katılımcıları yerel yaşam alanlarıyla etkileşime girmeye ve bu bitkilerin adaptasyonu ve başarısındaki kendi rolleri üzerinde düşünmeye teşvik etmektedir. Toprak stabilizasyonu, nem tutma, ısı adası tersine çevirme ve toksik biyolojik birikim gibi hizmetler sunan bu bozulmaya adapte olmuş bitkiler, değişen iklimin açtığı yaraları iyileştirmeye yardımcı olur ve mahalleleri hem insan hem de insan olmayan sakinler için daha yaşanabilir hale getirmeyi amaçlamaktadır.

İklim krizi, insan faaliyetlerinin doğa üzerindeki yıkıcı etkilerinin en belirgin sonucu olarak karşımıza çıkmaktadır. Bu kriz, sadece çevresel bir sorun değil, aynı zamanda sosyal, ekonomik ve politik boyutları olan çok yönlü bir mesele olarak da ele alınmaktadır. Sanatçılar, iklim krizine karşı farkındalık yaratmak ve çözüm arayışına katkıda bulunmak amacıyla çeşitli sanatsal stratejiler geliştirmişlerdir. Sanatçılar, eserlerinde iklim değişikliği ve çevresel bozulma konularını ele alarak, izleyicilerin bu konular hakkında bilgi sahibi olmasını ve düşünmesini sağlar. Örneğin, Olafur Eliasson'un "Ice Watch" projesi, Grönland'dan getirilen buz kütlelerinin Paris ve Londra gibi şehirlerde sergilenmesiyle, eriyen buzulların etkilerini doğrudan insanlara göstermeyi amaçlamıştır. Danimarkalı sanatçı Olafur Eliasson, iklim değişikliği konusunda farkındalık yaratmak amacıyla bu projeyi gerçekleştirmiştir. Eliasson, Grönland'dan getirdiği dev buz kütlelerini Paris, Londra gibi büyük şehirlerin meydanlarına yerleştirerek insanların bu buzların erimesine tanık olmalarını sağlamıştır. Bu çalışma, izleyicilere iklim değişikliğinin somut etkilerini doğrudan deneyimleme fırsatı sunarak, onları bu küresel krize karşı harekete geçmeye teşvik etmiştir.



Resim 3. Olafur Eliasson, Ice Watch, 2014, Londra

Olafur Eliasson Ice Watch isimli işi, Grönland'lı Jeolojist Minik Rosing ile birlikte 2014'te Tate Modern Londra'da gerçekleştirmiştir. Grönland'da karasal buzulların eriyip parçalara ayrılması sonucunda oluşan parçaları taşıyarak sanatçı bu yerleştirilmeyi gerçekleştirmiştir. Çalışma her biri 1 buçuk ile 6 ton arasında değişen 30 adet buz kütesinden oluşmaktadır. Sergileme buz parçaları tamamen eriyene kadar devam etmiştir. Sanatçı bu süre zarfında ziyaretçilerden buzlara dokunmalarını, hissetmelerini ve onları dinlemelerini istemiştir. Bu deneyimin iklim kriziyle ilgili bilimsel araştırmaların insanlarda harekete geçme anlamında yetersiz kaldığı noktada, olayın aciliyetine dikkat çekmek amacıyla kullanılmasını istemiştir. İnsanlarda bir davranış değişikliğine yol açabilmenin duyumsallaşmadan geçtiğini savunmuştur.



Resim 4. Maya Lin, What Is Missing, 2009

Çin asıllı Amerikalı Peyzaj Sanatı ve Heykel mimarilerinde ün yapmış mimar ve sanatçı Maya Lin'in "What Is Missing?" adlı eseri, kaybolan ekosistemler, türler ve doğal alanlara dikkat çeken bir multimedya çalışmasıdır. Lin, bu proje ile izleyicilere, insanlığın doğaya verdiği zararları hatırlatarak, iklim değişikliği konusunda bilinçlenme çağrısı yapar. Proje, aynı zamanda sürdürülebilir bir gelecek için neler yapılabileceği konusunda da çözüm önerileri sunar. Maya Lin'in bu eseri biyolojik çeşitlilik ve habitat kaybını çevreleyen mevcut kriz hakkında farkındalık yaratmaya adanmış, dokunaklı bir multimedya sanat eseridir. Heykel, geri kazanılmış sekoyalarla kaplı bronz "Dinleme Konisi"nden oluşmaktadır. Koninin içinde, nesli tükenmiş ve tehdit altındaki türleri, hayatta kalmaları için hayati önem taşıyan habitatlara ve ekosistemlere bağlayan 20 dakikadan fazla etkileyici video görüntüsü içeren bir ekran bulunmakta ve doğa-kültür ayrımının maddi etkilerine retorik olarak nasıl dikkat çektiğini anlamak için bir analizini sunmaktadır. Lin'in anıtı, görsel, işitsel ve metinsel öğeleri birleştirerek ve çevrimiçi bir arayüzde onarılamaz olanın yerini kullanarak doğal dünyayı korumayı savunmaktadır. Bu retorik stratejilerin birleşimi ve biçim ile içerik arasındaki etkileşim, doğayı tüketim nesnesi olarak çerçeveleyen insan bakışını bozar. Eser ayrıca, bu karşıt bakış açıları arasındaki gerilimi vurgulamak ve insan-doğa ilişkisine dair yeni anlayışlar için söylemsel açılımlar yaratmak için ustalık-uyum, ötekileştirme-bağlantı ve sömürü-idealizm diyalektiğini harekete geçirir.

İklim değişikliği ve yükselen deniz sularına dikkat çekmek için 57. Venedik Bienalinde İtalyan heykeltıraş Lorenzo *destek* adında bir heykel çalışması yapmış, kanalların içinden çıkan ve binaları saran devasa el yerleştirmesi ile 14. yüzyıldan kalan bir otelin duvarlarını destekleyerek dikkat çekmeyi hedeflemiştir. İklim değişikliği ve çürümenin yol açtığı zararlar ile yüzyıllardır kültürleri ilham veren bir yüzen sanat şehri olan Venedik'in sular altında kalması olasılığı onu bu işe yapmaya zorlamıştır.



Resim 5. Support, Lorenzo Quinn, 2017, Venedik

Sanatın Farkındalık Yaratma Gücü

Sanat, doğrudan bilgi aktarmaktan öte, izleyicilerin duygusal ve bilişsel deneyimlerini harekete geçirir. Bu bağlamda, sanatın iklim değişikliği ile mücadelede en önemli katkılarından biri, izleyicilerin konuyu daha derinlemesine ve duygusal bir düzeyde anlamalarını sağlamaktır. Sanat, karmaşık ve soyut olan iklim değişikliği kavramını somut hale getirir ve bu sayede daha geniş kitlelerin konuya dikkatini çeker.

Ülkemizde 2019'da 16.sı düzenlenen İstanbul Bienalinin başlığı olan *Yedinci Kıta* adını Antroposen çağının küresel ısınmayla birlikte en gözle görünür sonuçlarından biri olan, Pasifik Okyanusu'nun ortasındaki devasa atık yığınının almıştır. "Yedinci Kıta", 3,4 milyon kilometrekare genişliğinde yani Türkiye'nin 5 katı büyüklüğünde ve 7 milyon ton ağırlığında insan atıklarının okyanusun ortasındaki plastik yığınının meydana gelmektedir. 16. İstanbul Bienali, ekolojik sorunlar karşısında sanatın güncel durumunu pek çok sanatçı, düşünür, antropolog ve çevreci ile birlikte araştırmak için bir çıkış noktası oluşturmuş, İstanbul'un birçok noktasında sergilenerek sanatı, insanın etkilerini, takip ettiği yolları, bıraktığı izleri ve insan-olmayanlarla etkileşimini gözler önüne sermek için bir araç olarak kullanmış, insanlarda konuyla ilgili farkındalık yaratmayı hedeflenmiştir. İstanbul Bienali Direktörü Bige Örer ise, "İklim krizinin tartışmasız bir gerçek olduğu, insanların yaşam biçimlerini, üretim ve tüketim sistemlerini temelden değiştirmek zorunda oldukları bir zamandayız. Tüm bu acil tartışmalar içinde sanatın farklı perspektifler sunması, alternatif gelecek hayalleri kurması kaçınılmaz" demiştir (Özbek, 2019)

İKSİV 2021'de Doç. Dr. Hande Parker'in kaleme aldığı "Ekolojik Dönüşüm için Kültür ve Sanat" başlığı ile bir rapor yayınlamıştır. İklim ve çevreyle ilgili aciliyetlerin artması üzerine sanatsal ifade biçimlerinin de bu yöne eğilmesi gerekliliğine odaklanan rapor; insan doğa arasındaki ilişkileri yeniden düşünmeye, kurulabilecek yeni ağlara ve farklı disiplinlerin etkileşimine, iklim acil durumunda yaratıcı gücün önemine vurgu yapmaktadır.

Kültür-sanat alanının iletişim gücünü arkasına alarak kamuoyunda bir tartışma başlatmayı hedefleyen rapor, ekolojik krizi sosyal, politik, ekonomik ve kültürel yönleriyle tartışıp sürdürülebilirliğin nasıl tesis edilebileceğini mercek altına almayı amaçlıyor ve kültür-sanat aktörlerine ekolojik sorunları tüm boyutlarıyla değerlendirebilecekleri kapsamlı bir analiz sunuyor. Raporun aynı derecede önemli diğer bir amacı ise, kültür-sanat aktörlerinin ekolojik dönüşüm için eyleme geçmekte oynayabileceği etkin rolü vurgulamak.

Krizin çok boyutlu doğası yaratıcı üretimler sayesinde kamuoyuna farklı perspektiflerden aktarılırken, aynı zamanda ekolojik ayak izini azaltacak uygulamaları farklı aktörlerle araştırmaya açmıştır. Bir eylem planı oluşturmuş ve bu bağlamda hazırlanan ikinci bir raporla Türkiye'de kültür sanat alanında ekolojik bir dönüşümü amaçlayan alternatif yaklaşımları ve yeni pratikleri örneklemiştir.

SONUÇ

Sanat, tarih boyunca insan ve doğa arasındaki ilişkiyi farklı açılardan ele almıştır. Antik çağlardan beri doğa, mitolojik anlatılarda ve kutsal metinlerde önemli bir tema olmuş, Rönesans döneminde ise insanın doğayla uyum içinde yaşama arzusu sanatsal üretime yansımıştır. Romantizm döneminde doğa, insanın duygusal dünyasıyla ilişkilendirilmiş ve yüceltilmiştir. Ancak, Sanayi Devrimi ile birlikte doğa, insanın sömürdüğü ve tahrip ettiği bir kaynak olarak ele alınmaya başlanmıştır. Modern ve çağdaş sanatta ise doğa, insanın kontrol edemediği bir güç olarak yeniden değerlendirilmiş ve ekolojik kaygılar sanatsal üretimin merkezine yerleşmiştir. Sanatta insan-doğa

ilişkisi, doğanın yüceltilmesinden onun yıkımına, doğayla uyum arayışından onun tahrip edilmesine kadar geniş bir yelpazede ele alınmıştır. Bu ilişki, sanat tarihinin farklı dönemlerinde, toplumsal, kültürel ve teknolojik değişimlere bağlı olarak evrilmiştir. Günümüzde, insan-doğa ilişkisi, çevresel krizlerin ışığında yeniden ele alınmakta ve sanat, bu ilişkiyi sorgulamak, farkındalık yaratmak ve çözüm önerileri sunmak için önemli bir araç olarak kullanılmaktadır.

Bu araştırma kapsamında örneklenen güncel sanat örnekleri, sanatın bu mücadelede nasıl etkili olabileceğini gösteren güçlü araçlar sunar. Sanatçılar, eserleri aracılığıyla izleyicilerin dikkatini çekmekle kalmaz, aynı zamanda toplumsal bilinci artırarak çevresel eylemlere ilham verirler. Dolayısıyla, sanatın iklim değişikliği ile mücadelede daha fazla entegre edilmesi, hem politik hem de toplumsal düzeyde önemli sonuçlar doğurabilir. Artık günlük hayatlarımızı etkilemeye başlayan çevre krizi gibi aciliyeli bir konuda da etkin araçlardan haline gelecektir. Bu eserler, güncel sanatın çevre kirliliği, ekolojik kriz ve iklim eşitsizliği gibi küresel sorunları ele alarak nasıl toplumsal farkındalık yarattığını gösterir. Sanatçılar, bu eserler aracılığıyla izleyicileri bu sorunlarla yüzleşmeye ve harekete geçmeye teşvik ederler. Sanat, bu bağlamda, sadece estetik bir deneyim sunmanın ötesine geçerek, toplumsal değişim için bir araç haline gelir. Bu bağlamda güncel sanatta insan-doğa ilişkisi ve iklim krizine karşı sanatsal üretim, sadece estetik bir ifade aracı olmanın ötesine geçerek toplumsal bir sorumluluk üstlenmiştir. Sanatçılar, eserleri aracılığıyla izleyicileri bu krizle yüzleşmeye, çözüm arayışına katkıda bulunmaya ve harekete geçmeye teşvik etmektedir. Sanat, bu bağlamda, iklim krizine karşı güçlü bir çözüm ortağı olarak karşımıza çıkmakta ve toplumsal dönüşüm için önemli bir araç haline gelmektedir. Sanatın bu dönüştürücü gücü, insan-doğa ilişkisinin yeniden tanımlanmasında ve daha sürdürülebilir bir geleceğin inşasında kilit bir rol oynayacaktır.

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**DETERMINATION OF THE ECOLOGICAL VARIABLES AFFECTING THE FUTURE
GEOGRAPHICAL DISTRIBUTION OF ANATOLIAN WATER FROG LINEAGE
CILICIAN (GENUS *PELOPHYLAX*) IN TÜRKİYE**

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Abstract

Introduction and Purpose:

Climate change is a primary driver of amphibian decline. Among these, Anatolian water frogs (genus *Pelophylax*), with their permeable skin and their heavy reliance on watery habitats, are particularly vulnerable to environmental change. These frogs are crucial to healthy ecosystems and are economically valuable to Türkiye. However, climate change poses a threat to their future. Anatolian water frogs consist of several narrowly and widely distributed genetic lineages groups with unique genetic and ecological characteristics. Cilician water frogs, one of these narrowly distributed lineages, are found only east and west of the Amanos Mountains. This region is predicted to be strongly affected by climate change in the near future. Therefore, the objective of the present study was to predict which ecological variables, and how they affect the distribution of the Cilician water frog lineage in the current and future projections.

Materials and Methods: To assess the impact of climate change on the distribution of the Cilician water frog lineage, habitat suitability modeling was conducted using Maxent, a machine learning algorithm. Presence data for 165 individuals from western and eastern parts of the Amanos Mountains in Anatolia were employed in conjunction with 17 environmental variables, including climate projections for the present and future decades (2030, 2050, 2080, 2100) obtained from

Worldclim. Geographic Information Systems (GIS) were utilized to prepare the necessary data layers.

Model optimization through SDMtune improved predictive accuracy by tailoring Maxent parameters to the specific species. Model performance was evaluated using the AUC metric, jackknife testing, and response curve analysis

Results: The optimized Maxent model, incorporating seven key environmental predictors exhibited strong performance, with an AUC of 0.96 for training data and 0.88 for test data. Model optimization using SDMtune significantly improved predictive accuracy. Minimum temperature during the cold quarter, ruggedness, and temperature seasonality were identified as the most critical factors influencing habitat suitability for the Cilician water frog.

Discussion: These findings highlight the substantial impact of climate-related variables on species distribution. Additionally, based on the model predictions, the Cilician water frog lineage is expected to expand its range northwards in the coming years. This potential range expansion raises concerns that the species may become invasive.

Key Words: water frog, *Pelophylax*, Cilician lineage; Maxent; climate change; model optimization, Anatolia

INVESTIGATION OF THE IMPACT OF HIGHWAYS ON WILDLIFE IN THE KARABUK PROVINCE

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Abstract

Introduction and Purpose:

Karabuk province, which is located in the Black Sea region of Turkiye, consists of 72% forest areas. Yenice forests, one of the nine hot spots of Turkiye, are located in Karabuk province. This region, which harbours a rich biodiversity, is home to many different animal species. However, due to the insufficient number and improper placement of ecological bridges over highways, many species are killed in traffic accidents. This situation disrupts ecosystems by fragmenting natural habitats, damaging natural wildlife habitats and blocking migration routes, which in turn disrupts the balance of populations. The aim of this study is to investigate the negative effects of highways on wildlife within the borders of Karabuk and to evaluate the wildlife populations affected by traffic accidents over the course of a year.

Materials and Methods:

The study was conducted between June 2023 and July 2024. Collaboration was made with various official and private organisations and associations to report fatal wildlife accidents on the highways. Information such as the species of wild animals killed in the accidents, whether they were juveniles or adults, and the coordinates of the accident locations were recorded. Animals with undamaged fur were taken to the laboratory and preserved by taxidermy to be used as museum or teaching material in the Zoology Laboratory of Karabuk University Faculty of Forestry.

Results:

Our study identified a total of 22 individuals of seven different mammal species that were killed in highway accidents. All identified individuals were adults. The identified species include one wolf (*Canis lupus*—Ovacık district), four jackals (*Canis aureus*—Taskopru area, Kemaloyman area), one fox (*Vulpes vulpes*—Eflani), two stone martens (*Martes foina*—Demircelik area, Eflani), two badgers (*Meles meles*—Ovacık, Yenice), ten porcupines (*Erinaceus concolor*—city and district centre) and two squirrels (*Sciurus anomalus*—Eflani). This study only includes accidents that occurred within a certain period of time and is limited to the province of Karabuk. However, considering that there may also have been deaths in accidents that were not reported to us, the actual number of animals killed is probably much higher. In order to prevent losses due to road accidents, it is necessary to regulate road crossings, build ecological bridges in areas where wild animals cross and monitor these crossings.

Keywords: Wildlife; Ecological bridge; Mammal species; Highways

**THE ROLE OF SAPONINS IN THE RESTORATION OF PHOTOSYNTHETIC
REACTIONS OF THE THYLAKOID MEMBRANES DAMAGED BY THERMAL
STRESS**

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Abstract

Introduction and Purpose: The plant body has various effective defense systems against stress factors. Secondary metabolites in plant cells, which have a rich set of antioxidants, play an important role in inhibiting free radical oxidation. One such compound is triterpene saponins.

Materials and Methods: Saponins obtained from licorice root (*Glycyrrhiza glabra* L.) showed high antioxidant activity by the DPPH method. In the IR absorption spectrum, peaks in the range $1626.5220.007-1397.508.0.002 \text{ cm}^{-1}$ were identified, characterizing glycyrrhizic acid. The effect of

saponins on the activity of photosynthetic parameters of the thylakoid membrane with changes in environmental temperature was studied. Wheat seedlings grown in an aqueous environment in the presence and absence of saponins were subjected to cold stress (4°C) for a certain period.

Results: The absorption spectrum of photosynthetic pigments and fluorescent characteristics of ms delayed fluorescence showed a decrease in electron transfer activity at the P680-Q_A-Q_B site in PS II, and a decrease in the accumulation of the main forms of light energy harvesting pigments - Chl *a*₆₈₀ and Chl *b*₆₄₅ in the absence of saponins. Saponins actively promoted the reduction of photochemical reactions causing electron transfer on both the donor and acceptor side and the accumulation of light harvesters. A sharp change in temperature (4°C–30°C) led to a drop in the studied parameters. However, in the presence of saponins, these changes are less pronounced on the donor side of PSII and in the stability of Chl *a*₆₈₀.

Discussion and Conclusion: We believe that protection by saponins is due to its antiradical properties. The rate of e-transfer and Chl *a*₆₈₀ uptake increase with a long hour-long period of stress, which is likely due to the restoration of membrane fluidity by saponins and the efficiency of functioning of e- protein transporters. It is known that the action of saponins depends on changes in intracellular pH and temperature, which possibly occurs with a sharp change in temperature. Probably, under these conditions, saponins have a different mechanism of action, demonstrating their ability to stabilize the lipid part of the membrane.

Key Words: PS II; Electron transport; Photosynthetic pigments; Saponin.

**ZIRCONIA PARTICLE-ENHANCED CERAMIC: IMPROVED
PHOTODEGRADABILITY BEHAVIOR TO ORGANIC CONTAMINANTS**

**ZİRKONYA PARÇACIKLARLA GELİŞTİRİLMİŞ SERAMİK: ORGANİK
KİRLETİCİLERE KARŞI İYİLEŞTİRİLMİŞ FOTOBOZUNMA DAVRANIŞI**

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ÖZET

Kendi kendini temizleyen malzemeler, yüzeylerin kir, leke ve diğer kirleticilerden otomatik olarak temizlenmesini sağlayan özel kaplamalar ve teknolojiler içerir. Bu malzemeler bakım gereksinimlerini azaltarak uzun vadeli temizlik sorunlarını en aza indirmelerinden dolayı genellikle dış cephe kaplamaları, zeminler ve diğer yoğun kullanım alanlarında tercih edilmektedir. Fotokatalitik reaksiyon, antimikrobiyal özellikler ve su iticilik gibi mekanizmalar malzemelerin kendi kendini temizleme özelliği sunmasını sağlar.

Bu çalışma, gün ışığına maruz kaldığında kimyasal reaksiyonları başlatabilen ZrO₂ parçacıklarıyla hazırlanan yer seramiklerinin organik maddeleri bozundurma yeteneğini araştırmayı amaçlamaktadır. İlk olarak, zirkonya (ZrO₂) parçacıkları, sol-jel yöntemiyle zirkonyum izopropoksitten sentezlendi. Ardından, ZrO₂ parçacıkları %3 kütle oranında yer seramiklerine eklendi, kalıplandı ve 1200 °C'de sinterlendi. Elde edilen ürünün morfolojisini ve kristal yapısını belirlemek için X-ışını kırınımı (XRD) ve taramalı elektron mikroskopu (SEM) kullanılarak karakterize edildi. Son olarak, ZrO₂ katkılı yer seramiğinin organik kirleticilere karşı fotobozunma yeteneği, model kirletici olarak seçilen Metilen Mavisi boyası kullanılarak belirlendi. Fizikokimyasal karakterizasyonlar zirkonya parçacıklarının yer seramiği yapısına başarıyla entegre edildiğini gösterdi. Ayrıca, ZrO₂ ile güçlendirilmiş seramiğin, Metilen Mavisi çözeltisinin (50 mg/L) %70'ini gün ışığında giderdiği tespit edildi. Bu bağlamda, önerilen zirkonyum oksit (Zirkonya) ile güçlendirilmiş yer seramikleri, boyanın fotobozunma ile giderilmesinde umut verici olduğu düşünülmektedir. Bu çalışma, son yıllarda yapı malzemelerinde giderek daha önemli hale gelen kendi kendini temizleyen malzemelere bir alternatif sunmaktadır.

Anahtar Kelimeler: Zirkonyum oksit, Zemin seramiği, Fotobozunma, Metilen Mavisi

Abstract

Self-cleaning materials have special coatings and technologies that enable their surfaces to automatically clean themselves of dirt, stains, and other contaminants. These materials are generally preferred for exterior cladding, floors, and other high-use areas because they minimize long-term cleaning problems by reducing maintenance requirements. They typically offer photocatalytic reaction, antimicrobial properties, water impermeability, and self-cleaning. These materials are coated with particles that make it difficult for surfaces to hold dirt and make them easier to clean.

This study investigated the ability of floor ceramics prepared with ZrO_2 particles, which can initiate chemical reactions when exposed to daylight, to degrade organic substances. Firstly, zirconia (ZrO_2) particles were synthesized from zirconium isopropoxide by the sol-gel method. Then, subsequently, ZrO_2 particles were added to the floor tiles at a mass fraction of 3 %, molded, and sintered at 1200 °C. The resulting product was characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM) to determine morphology, and crystalline structure. Finally, the photodegradation ability of ZrO_2 -doped particles to organic contaminants was determined using Methylene Blue dye as a model.

Physicochemical characterizations showed that zirconia particles were successfully incorporated into the structure of the floor ceramic. In addition, the ZrO_2 -reinforced composite ceramic was found to remove 70% of the methylene blue solution (50 mg/L) selected as a model pollutant in daylight. In this context, the proposed zirconium oxide (zirconia) reinforced floor ceramics are promising in the photodegradation removal of the paint selected as a model. This study presents an alternative to self-cleaning materials, which have become increasingly important in building materials in recent years.

Key Words: Zirconia; Floor tiles; Photodegradation, Methylene Blue

GİRİŞ

Kolay temizlenen ve hatta kendi kendini temizleyen yeni yüzeylerin geliştirilmesi son yıllarda, mühendislik, yapı malzemeleri ve konfor düzeyinin yükselmesi ile de mimari tasarım alanlarında ilgi odağı olmuştur (Paola ve ark. 2012). Bu sebeple özellikle iç ve dış ortamlarda kullanılan yer seramikleri üzerinde biriken kir, leke ve patojenler gibi kirleticilerin giderilmesi insan ve çevre sağlığı için önemli araştırma konularından biri haline gelmiştir.

Kendi kendini temizleyen malzemeler doğadan ilham alarak çeşitli yenilikçi yöntemler kullanılarak üretilmektedir. Özellikle lotus yaprakları veya geko ayakları gibi yüzeylerde bulunan mikro ve nano yapılar taklit edilerek, tekstil ve cam dahil olmak üzere çeşitli malzemelerde kendi kendini temizleme özelliklerini artırılmaktadır. Öne çıkan yaklaşımlardan biri, suyu iten ve lotus yapraklarının özelliklerini taklit eden süperhidrofobik yüzeylerin oluşturulmasıdır. Bu yüzeyleri geliştirmek için plazma veya iyon aşındırma, nanolitografi ve kristal büyümesi gibi teknikler kullanılır ve damlacıkların yuvarlanıp kiri beraberinde taşımasına izin veren yüksek su temas açılırları elde edilir (Yu ve ark., 2020). Bunun yanı sıra, son yıllarda UV ışığını kullanarak organik maddeleri parçalayabilen serbest radikaller oluşturan fotokatalitik kaplamalar, yüzeydeki suyun yayılmasını sağlayarak daha etkili bir temizlik için süperhidrofilik özelliklerle birleştirilir (Aniedi ve ark., 2021).

Fotokatalitik malzemeler (veya kaplamalar), gün ışığı veya yapay iç mekan aydınlatma enerjisi kullanarak organik ve inorganik kirleticilerin bozunmasını sağlayan kendi kendini temizleyen çevreyle dost yarıiletken malzemelerdir (Usern ve Bondi, 2013). Bu malzemeler yüzeyde bulunan kir, leke ve diğer kirletici (bakteri, virüs, mantar) bileşenler kendiliğinden bozularak

uzaklaştırıldığından klorlama, ozonlama, adsorpsiyon ve mikrofiltrasyon gibi farklı kimyasal, fiziksel ve biyolojik temizlik, bakım işlemlerinin kullanımını da en aza indirerek çevre kirliliğini de önlemede önemli bir rol oynar (Unverdi ve ark., 2016; Tong ve Hunte, 2012; Benedix ve ark., 2000; Fujishimave ark., 2000). İdeal bir fotokatalizör malzeme; iyi bir fotokatalitik aktiviteye sahip olmalıdır. Aynı zamanda biyolojik ve kimyasal olarak inert, görünür ışık veya yakın ultraviole (UV) ışığını absorblamaya uygun, fotokorozyona karşı dayanıklı, ucuz ve toksik olmayan özelliklere sahip olmalıdır (Mishra ve Chun, 2015). Bu fotokatalizörler malzemeler uygun dalga boylarındaki radyasyonu absorblayarak uçucu organik bileşiklerin, zararlı bakterilerin ve diğer kirleticileri buldukları ortamda parçalayabilen reaktif oksijen türlerinin (ROS) oluşumunu kolaylaştırarak H₂O ve CO₂'ye dönüştürür (Balte, 2009).

Fotokatalizör malzemelerin elektronik band yapısı, elektronlarla (e⁻) dolu bir değerlik bandı (VB) ile iletim bandı (CB) arasında yaklaşık 2-5 eV enerji band aralığı (Eg) şeklindedir. Eg ne kadar dar ise fotokatalitik etki de o kadar yüksektir. Dışarıdan gönderilen yeterli bir foton enerjisi (UV veya görünür ışık) ile uyarıldıklarında VB'deki elektronlar enerji bandını aşarak CB ulaşır ve VB'de eşit sayıda delik (h⁺) bırakır. Genel olarak kabul edilen fotokataliz modeline göre (Mills ve ark. 1997), bu elektron-delik yük taşıyıcılarının fotokatalizörün yüzeyine yayılarak kimyasal reaksiyona girerler. Yüzeyde kuvvetli yükseltgen türleri olan radikalleri (oksid, peroksit ve hidroksil radikalleri) oluşturarak zararlı organik moleküllerin su ve karbon dioksit gibi zararsız türleri oluşturan reaksiyona göre bozunmasını sağlar.

Zirkonyum oksit veya Zirkonya (ZrO₂) geniş enerji band aralığına (~ 5eV) sahip olmasına rağmen UV ışığı altında metal oksitler arasında en aktif fotokatalizörlerden biridir. ZrO₂ etki spektrumu iki spektral bölgeye ayrılabilir: (i) banttan banda elektron geçişlerinin neden olduğu içsel temel absorpsiyona ($\lambda < 250$ nm) karşılık gelen bir spektral bölge ve (ii) kusurlar ve yüzey durumları tarafından dışsal ışık absorpsiyona karşılık gelen bir spektral bölge (250–400 nm). Özellikle, toz halindeki zirkonyum oksit üzerinde oksijen, hidrojen, metan ve etanın fotostimülyasyonlu adsorpsiyonu için foto-uyarılmanın kırmızı spektral kenarının yaklaşık 3,0 eV'de ($\lambda \sim 410$ nm), yani dışsal absorpsiyon bant bölgesinde olduğu gösterilmiştir (Rudokova 2018). Bununla birlikte ZrO₂ biyoyumlu, yüksek kimyasal foto- ve termal kararlık, mükemmel sertlik ve aşınma direnci gösterir (Kelly ve Denry, 2008). Yer/duvar seramikleri zorlu çevresel şartlara, yüksek kirliliğe, asidik ve bazik ortamlara, yüksek basınçlara, sert temizliğe ve dezenfeksiyon işlemlerine çok sık maruz kalmaktadır. Bu nedenle yer seramiklerine katılanması ile diğer metal oksit fotokatalizörlerin başarısız olduğu yerlerde tercih edilebilir olması ZrO₂'in önemli ve farklı yönlerini göstermektedir. [Zhongyang ve ark., 1996; Eray ve ark., 2020; Cohelho ve ark., 2021].

Yaşam alanlarımızın (ofis, ev, hastane odaları, okullar, kütüphane, laboratuvar vb.) her noktasında yer seramikleri yer almaktadır. Dolayısı ile bu ortamların sürekli temiz tutulması insan sağlığı açısından önemlidir. Bu çalışmada, ZrO₂ katkısı ile standart yer seramik malzemelerine fotokatalitik aktivite kazandırılarak UV ışığına maruz kalan bütün yüzeylerde kendi kendini temizleyen yüzeye sahip seramik yapı malzemesi elde edilmesi amaçlanmıştır. Böylece temizlik ürünleri kullanımı azaltılarak fosfat, klor, ftalat gibi kalıcı kirleticilerden kaynaklanan çevresel sorunların azaltılmasına katkı sağlayacağı değerlendirilmektedir. Bunun yanı sıra, ZrO₂'in gelişmiş antibakteriyel özelliği ve üstün mekanik özelliği sayesinde yer seramiklerinin kullanım ömrünün artıracığı da düşünülmektedir.

KAVRAMSAL ÇERÇEVE

Kendi kendini temizleyen malzemeler, sık sık dışarıdan müdahale olmadan yüzey temizliğini sağlamak yada korumak için tasarlanmış, yüzeylerdir. Bu malzemeler öncelikle iki mekanizma üzerinden çalışır: Fotokataliz ve süperhidrofobite. TiO_2 , ZnO , CeO_2 , WO_3 , ZrO_2 , Fe_2O_3 gibi ikili oksitler, $BiVO_4$ ve Ag_3PO_4 gibi kompleks metal oksitler, CdS , ZnS ve MoS_2 gibi metal sulfidler ve Grafen ve Grafitik Karbon Nitrür gibi metal-içermeyen malzemeler fotokatalizör olarak kullanılmaktadır (Zhao 2003, Mo 2009, Cao 2015, Wang 2015). Fotokatalitik malzemeler, yüzeydeki organik kirleticileri parçalayan reaktif oksijen türleri (ROS) üretmek için UV ışığından yararlanır. Bu süreç genellikle hidrofilik bir yüzey sağlanarak güçlendirilir ve suyun yüzey boyunca eşit şekilde yayılmasına izin verilerek bozunmuş parçacıkların giderilmesine yardımcı olur. Fotokatalitik yüzeyin aksine, süperhidrofobik yüzeyler ise yüksek su temas açıları sergiler ve su damlacıklarının boncuklanıp yuvarlanması sırasında kirliliklerin uzaklaştırılmasını sağlar. Bu "lotus etkisi" genellikle hidrofobik kaplamalarla birleştirilmiş mikro ve nanoyapılar uygulanarak elde edilir. Bu malzemelerin tasarımı ve sentezi, sol-jel işlemleri, kimyasal buhar biriktirme (CVD) ve nanoyapıların dahil edilmesi gibi gelişmiş teknikleri içerir. Bu teknolojiler, cam cephelerde ve yer/duvar seramiklerde bakım ihtiyacını azaltmak için kullanıldığı mimaride, otomobil yüzeylerinin temiz tutulmasına yardımcı olduğu için otomotiv endüstrisi ve leke tutmayan ve antimikrobiyal kumaşlar oluşturduğu için tekstil endüstrisi gibi çeşitli endüstrilerde uygulamalara yol açmıştır.

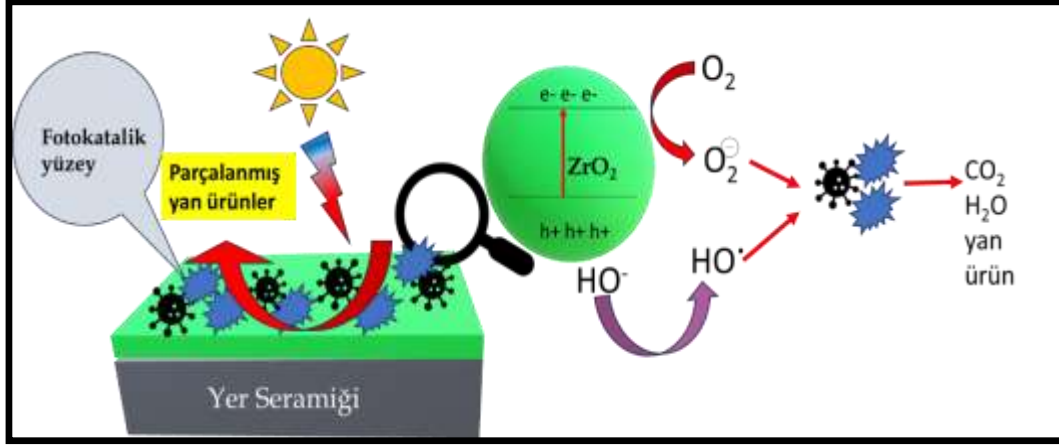
Yapı malzemeleri açısından değerlendirildiğinde, beton, boya, cam ve seramik malzemelerin çeşitli fotokatalizörler uygulanarak kendi kendini temizleme özelliği kazandırıldığı çalışmalar arasında bina cepheleri için betonda TiO_2 ve SiO_2 fotokatalizörlerinin kullanımı gösterilmiştir. Doğrudan beton karışımına dahil edilebilen ya da kaplama olarak uygulanabilen bu fotokatalizörlerle işlenen beton yüzeylerin çevre koşullarına maruz kaldığında zamanla daha temiz kaldığını ve kir ve kirleticilerin birikimini etkili bir şekilde azalttığını göstermiştir (Lapidus 2022). Betonun yanı sıra, fotokatalitik katkı maddeleri içeren çeşitli boyalar geliştirilerek, ışığa maruz kalan yüzey üzerinde biriken organik kirleticilerin ayrıştırabilmiştir. Bu boyalar duvarlara ve diğer yapılara uygulanabilir ve havadaki ve yüzeylerdeki zararlı maddeleri parçalayarak daha temiz ortamlara katkıda bulunabilir (Rabajczyk ve ark., 2021).

Fotokatalitik yolla kendi kendini temizlemede en yaygın kullanılan uygulamalarından biri cam yüzeylerdir. Cam üzerinde yaygın olarak kullanılan titanyum dioksit kaplamaları, UV ışığına maruz kaldığında fotokatalitik reaksiyonlara girerek organik kirleticileri parçalayan ROS türlerini üretir. Bu işlem, suyun yüzeyde yayılmasına ve yağmur sırasında parçalanmış yan ürünlerin giderilmesini sağlayan süperhidrofilik bir ortam ile elde edilir (Wei ve ark., 2023). Cama benzer şekilde, seramik karolar kendi kendini temizleme özellikleri elde etmek için TiO_2 gibi fotokatalitik malzemelerle kaplanabilir. Karolar organik kirleticileri ayrıştırır ve güneş ışığına maruz kaldığında temizliğini korur. Bu, onları bina cephelerinde ve diğer dış uygulamalarda kullanıma uygun hale getirir (Rabajczyk ve ark., 2021).

Bu örnekler ışığında, bina uygulamaları için kendi kendini temizleyen yüzeyler oluşturmada fotokatalitik malzemelerin çok yönlülüğünün sağlayacağı avantajlar düşünülerek, daha temiz ortamlara ve azaltılmış bakım gereksinimlerine katkıda bulunacak ve uzun vadeli dayanıklılık ve performansın sağlayabilecek yapı malzemesinin geliştirilmesi amacıyla bu çalışmada zirkonyum oksit içeren yer seramiği tasarlanmıştır.

Zirkonyum oksit parçacıkları, özellikle yüksek sıcaklık ve sert kimyasal ortamlara karşı dayanıklılık gösteren olağanüstü termal ve kimyasal kararlılıkları nedeniyle bir fotokatalizör olarak çeşitli avantajlar sunar. Bu kararlılık, uzun süreli kullanımlarda mekniksel ve kimyasal dayanıklılık sağlayarak zirkonyumu diğer fotokatalizörlerin bozulabileceği uygulamalar için uygun hale getirir

(Mansori 2019). Zirkonyum ayrıca düşük fotokorozyon sergiler ve uzun süreli ışık maruziyetinde bütünlüğünü korur (Teeparthi 2018). Zirkonyum oksit ayrıca kompozit fotokatalizörlerde destek malzemesi olarak kullanılır; örneğin TiO_2 gibi aktif parçacıkların dağılımını ve kararlılığını artırır, elektron-delik rekombinasyonunu azaltır ve böylece genel fotokatalitik verimliliği iyileştirebilir. Bu kapsamda bu çalışmada, yapı malzemelerinde yaygın olarak kullanılan seramik malzeme zirkonyum parçacıklar ile modifiye edilerek, fotokatalitik olarak kirleticileri uzaklaştırma kabiliyeti model kirletici olarak boya kullanılarak belirlenmiştir. Çalışmanın temel çerçevesi Şekil 1’de verilen şematik diyagram ile gösterilmiştir.



Şekil 1. Çalışmanın temel çerçevesini gösteren şematik diyagram

YÖNTEM

Zirkonya Parçacıkların üretilmesi

Zirkonya parçacıkları daha önce literatürde kaydedilmiş çalışma öncülüğünde hazırlandı (Heshmatpour ve Aghakhanpour, 2011). Bu amaçla zirkonyum propoksit ($Zr(OCH_2CH_2CH_3)_4$) izopropanol ortamında çözünerek homojen bir çözelti oluşturuldu. Daha sonra ortama seyreltik amonyak eklenerek çözelti oda sıcaklığında 1 saat boyunca karıştırıldı. Elde edilen partiküller $110\text{ }^\circ\text{C}$ 'de 12 saat kurutuldu.

Zirkonya içeren yer seramiği üretimi

Seramik toz (%38 feldispat, %25 kaolen, %20 kil ve %17 kuvars mineralleri içeren) yüksek enerjili öğütme ortamında WC hazne ve WC bilyalar ile öğütüldü, elde edilen homojen karışım yüksek basınçlı presle $1 \times 0.5 \text{ cm}$ ölçülerinde kalıp kullanılarak dairesel geometride elde edildi ve $1200 \pm 50\text{ }^\circ\text{C}$ 'de $10\text{ }^\circ\text{C}/\text{dak.}$ ısıtma hızında 1 saat boyunca sinterlenerek standart yer seramiği olarak belirlendi. Zirkonya içeren yer seramiğinin üretimi ise, yukarıda anlatılan işlemlerin kütleye %3 ZrO_2 varlığında gerçekleştirilmesi sağlandı. Böylece standart ve ZrO_2 takviyeli yer seramiği elde edildi.

Karakterizasyon

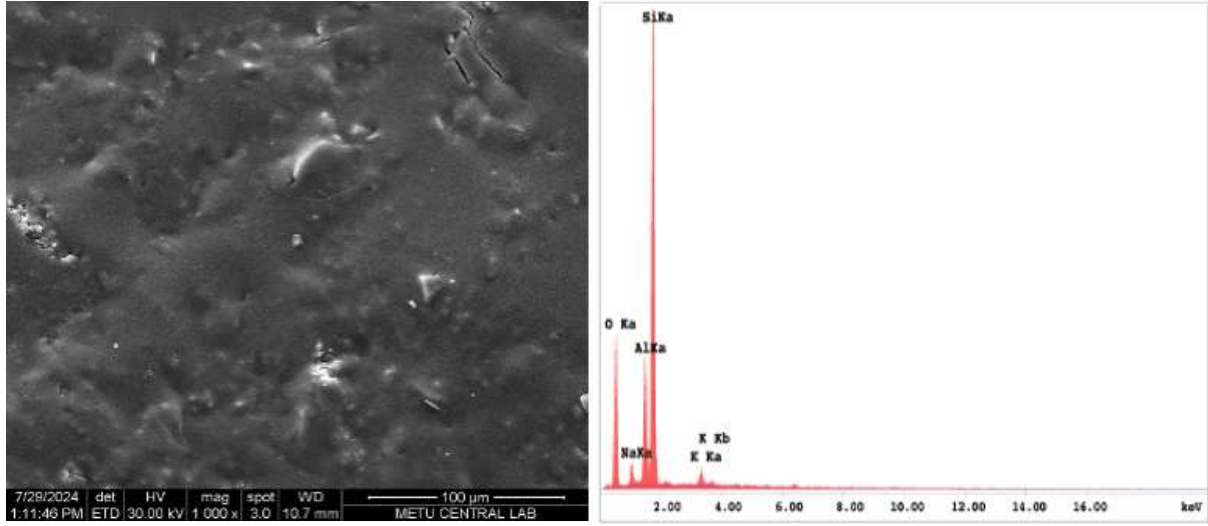
Mikroyapı özellikleri Taramalı Elektron Mikroskobu (QUANTA 400F Alan Emisyon SEM) ile elemental analizleri ise Enerji Saçılımlı X-ışınları spektrometre (EDX) analizleri ile belirlendi. Yer seramiklerinde oluşan fazlar ve kristalografik özellikleri $10^\circ \leq 2\theta \leq 90^\circ$ tarama aralığında, 5 derece/dak. tarama hızında X-ışını kırınımı (XRD, Rigaku Ultima-IV) $CuK\alpha$ hedef ($\lambda_{Cu}=0,1540 \text{ nm}$) kullanılarak tespit edildi. XRD verileri ASTM standartlarına göre yorumlandı.

Fotokatalitik Etkinin belirlenmesi

Zirkonya partiküllerinin yer seramiğinin fotokatalitik davranışına etkisi model kirletici olarak metilen mavisi (MB) kullanılarak belirlendi. Bu amaçla, 1 g standart ve ZrO_2 takviyeli yer seramiği 25 ml 50 ppm MB çözeltisi içine aktarılarak fotokatalizörde 365 nm UV ışığına maruz bırakıldı. 2 saat sonunda ortamdaki MB çözeltisinin derişimi UV-vis spektrofotometre (Shimadzu-1280) ile 665 nm’de absorbansının okunması yoluyla belirlendi.

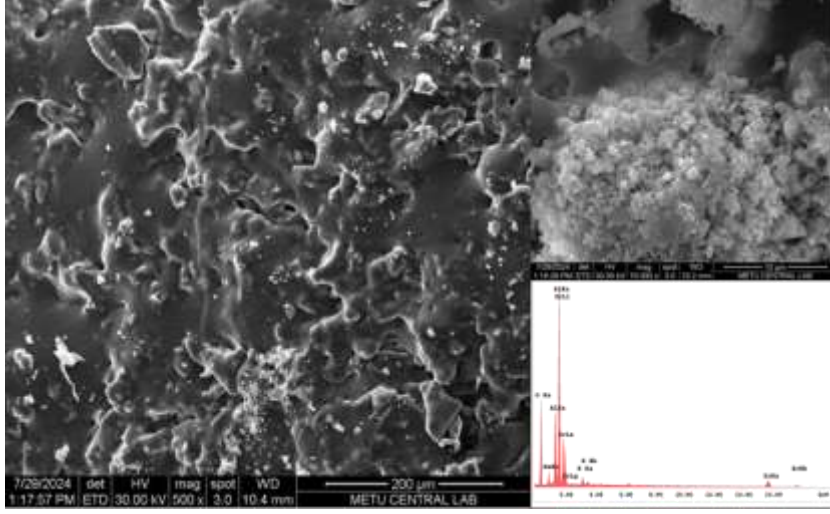
SONUÇ VE TARTIŞMA

Standart ve ZrO_2 katkılı yer seramiklerinin SEM ve EDX spektrumları sırasıyla Şekil 2 ve 3’de verilmiştir.



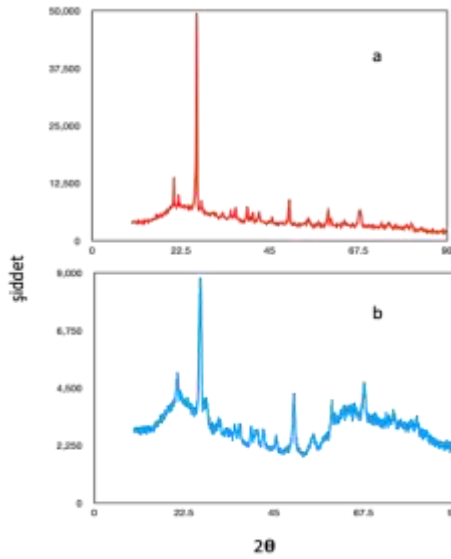
Şekil 2. Standart yer seramiğinin SEM mikrografı ve EDX spektrumu

Yukarıda anlatılan yöntem ile elde edilen standart yer seramiğinin SEM fotoğrafına bakıldığında yüzeyin genel olarak pürüzsüz ve düzensiz olduğu görülmektedir (Şekil 2), EDX spektrumu incelendiğinde ise, içerisinde genel yer seramik bileşenlerine ait kimyasal bileşikler olan SiO_2 (%43,01), Al_2O_3 (%9,67), Na_2O (%3,50) ve K_2O (%1,62) bileşiklerinin olduğu belirlenmiştir. Daha önceki bir çalışmada, seramiğin düzensiz geometride topaklanmaların bulunduğu yüzey yapılarına sahip olduğu bildirilmiştir (Güner 2017). ZrO_2 katkılı seramik malzemenin SEM fotoğraflarına bakıldığında (Şekil 3) ZrO_2 ’lerin yüzeye sıkıca bağlandığını ve genel olarak homojen dağıldığı görülmektedir. Bu sonuç yer seramikleri için önemli bir özellik olup çizilme direncinin artmasına olanak sağlayabilir. ZrO_2 katkılı yer seramiğinin kimyasal bileşen içeriği Şekil 3’de EDX spektrumu ile ZrO_2 varlığı belirlenmiştir.



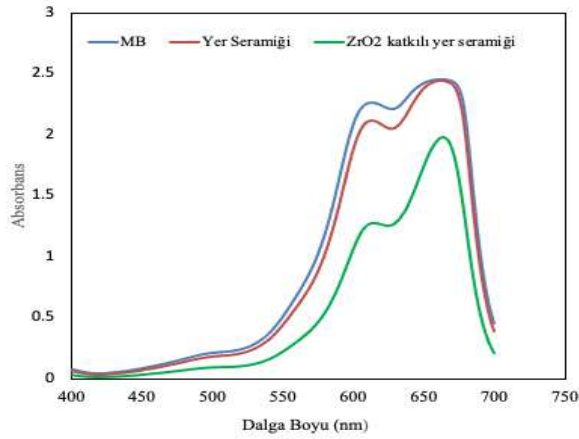
Şekil 3. ZrO₂ katkılı seramiğin SEM mikrografları ve EDX spektrumu

Seçici ve yüksek kaliteli bir yer seramiği elde etmenin temel koşulu homojen ve kusursuz bir üst tabakadır. ZrO₂ genellikle üç farklı kristal yapıda bulunmaktadır: Monoklinik, tetragonal ve kübik. Monoklinik faz 1170°C'ye kadar kararlı yapıya sahip olmakla birlikte 2370 °C'nin üzerinde tetragonal faza, daha yüksek sıcaklıklarda ise yüzey merkezli kübik kristal yapıya dönüşür (Akbas ve ark., 2016). Yer seramikleri sinterleme aşamasında hacim değişimi nedeniyle yüzeyde çatlaklar oluşturabilir. Bunu engellemek için zirkonyum monoklinikten tetragonale faz dönüşümünü önlemek gerekir. Genellikle ZrO₂ fazını stabilize etmek için doping elementler (İtriyum, TiO₂ vb) ilave edilir (Witz ve ark., 2007). Şekil 4' de standart ve ZrO₂ katkılı yer seramik numunelerin XRD spektrumları verilmiştir. Buna göre Şekil 4a'da % 100 yakın kuvars (SiO₂) kristal yapı gözlenirken Şekil 4b'de kuvars ile birlikte ZrO₂ fazları bulunmaktadır. Katkılı yer seramiğinde ZrO₂ fazlarının %100 monoklinik (baddeleyit) kristal yapılı olması yüzey çatlak oluşumunu en aza indirdiği değerlendirilmiştir.



Şekil 4. Standart Seramik (a) ve ZrO₂ katkılı seramiğin (b) XRD spektrumu

Şekil 5 Model kirletici olarak seçilen MB çözeltisinin yer seramiği ve ZrO₂ katkılı yer seramiği ile fotokatalitik olarak etkileştikten sonraki spektrumu görülmektedir. Grafik aynı zamanda MB çözeltisinin aynı koşullardaki fotokatalitik ortamadaki spektrumunu da göstermektedir. MB'nin maksimum absorbands yaptığı dalga boyunda ($\lambda=665$ nm), yer seramiğine göre ZrO₂ katkılı seramiğin boyanın bozunmasını desteklediği görülmektedir. Buradan 50 ppm'lik MB çözeltisinin 1 g ZrO₂ katkılı yer seramiği ile %70 oranında bozunarak temizlenebileceği söyleyebilir.



Şekil 5. Fotokatalitik etki (50 ppm MB çözeltisi, pH 7)

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**EVALUATION OF FOREST ROAD NETWORKS WITHIN KASTAMONU REGIONAL
FOREST DIRECTORATE**

**KASTAMONU ORMAN BÖLGE MÜDÜRLÜĞÜ ORMAN YOLLARININ
DEĞERLENDİRİLMESİ**

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ÖZET

Ormanlar, hayatın her safhasında ihtiyaç duyulan yaklaşık 6000 farklı kullanım alanı olan odun ve odun dışı orman ürünleri hammadde kaynağıdır. Bunların yanı sıra günümüzde daha çok öne çıkan farklı boyutu da biyolojik çeşitlilik, karbon depolaması, oksijen kaynağı olması, yer üstü ve yer altı sularını düzenlemesi, iklime olumlu etki yapması, erozyonu önlemesi gibi sosyal faydaları ile dünyanın vazgeçilemez ortak değerleri arasında yerini almıştır. Yenilenebilir doğal kaynaklardan olan ormanlardan faydalanmanın sürekli hale getirilmesi bunun yanında gelecek kuşakların ihtiyacını karşılayabilmesi için koruma- kullanma dengesinin sağlanması ve ormanların sürdürülebilir optimum verimliliği sağlayacak modern yöntemlerle yönetilmesi gerekmektedir. Sürdürülebilir orman yönetiminde, ormanlarda yapılmakta olan kesim, taşıma, bakım, yetiştirme, koruma, hasılat, orman yangınlarına müdahale, orman civarında yaşayan insanlara ulaşım sağlama ve tüm ormancılık faaliyetlerinde orman yolları kullanılması gerekliliği bulunmakta olup bu durum orman yollarının planlanmasının önemini ortaya çıkarmaktadır. Büyük miktarda gerçekleşen ve gelecekte de yapılması gerekli olan orman yol ağı yatırımlarını hem doğru kullanmak hem de doğada kalıcı bir iz bırakan orman yollarının çevreye minimum zarar vermesini sağlamak, çağdaş bir orman işletmeciliği gereğidir.

Çalışma kapsamında Kastamonu Orman Bölge Müdürlüğü plan verilerinden, Orman Genel Müdürlüğü resmi internet sitesinde mevcut bulunan bilgi ve belgelerden faydalanılarak gerekli değerlendirmeler yapılmıştır.Yapılan değerlendirme sonucunda Kastamonu ilinde mevcut orman yolu uzunluğunun 11031 km olduğu, planlanan orman yolu ağı uzunluğuna erişilebilmesi için 8139 km yeni orman planlanması gerektiği belirlenmiştir. Planlanacak bu yollar için tomruk satış gelirini de göz önüne alarak yapım maliyeti için 1.232.448.075 TL kaynak ayrılması durumunda kaynak sıkıntısının yaşanmayacağı öngörülmüştür.

Key Words: Orman yolları, Planlama, Kastamonu

Abstract

Forests are a raw material source for wood and non-wood forest products, with approximately 6000 different uses needed at every life stage. In addition to these, it has taken its place among the indispensable common values of the world with its social benefits such as biological diversity, carbon storage, being a source of oxygen, regulating surface and groundwaters, positively affecting climate, and preventing erosion. To make the utilization of forests, which are renewable natural resources, continuous and to meet the needs of future generations, it is necessary to ensure the balance between protection and utilization and to manage forests with modern methods that will ensure sustainable optimum productivity. In sustainable forest management, it is necessary to use forest roads in all forestry activities such as cutting, transport, tending operation, cultivation, protection, harvesting, intervention to forest fires, providing transportation to people living around the forest and all forestry activities, and this situation reveals the importance of planning forest roads. Modern forest management requires to use the of forest road network investments, which are realized in large amounts and which need to be made in the future, both correctly and to ensure that the forest roads, which leave a permanent trace in nature, cause minimum damage to the environment.

Within the scope of the study, necessary evaluations were made by using the plan data of the Kastamonu Regional Directorate of Forestry and the information and documents available on the official website of the General Directorate of Forestry. As a result of the evaluation, it was determined that the existing forest road length in Kastamonu province is 11031 km, and 8139 km of new forest should be planned to reach the optimum planned forest road network length. It is predicted that there will be no resource shortage if 1.232.448.075 TL resource is allocated for the construction cost considering the log sales revenue for these roads to be planned.

Keywords: Forest roads, Planning, Kastamonu

GİRİŞ

Türkiye 26°-45° Doğu meridyenleri ile 36°-42° Kuzey paralelleri arasında yer alır. Türkiye; özel konumu sonucunda Asya, Avrupa ve Afrika kıtaları arasında köprü durumundadır. Bu nedenle konumu itibariyle önemlidir. Bununla birlikte Türkiye 783.562 km² alana sahip olup 2022 yılında yapılan envanter çalışmalarına göre bu alanın %29.8'i (23.245.000 ha) ormanlardan oluşmaktadır. Kastamonu ili orman alanlarının yoğunluğunun yanında orman servetiyle de ön plana çıkmaktadır. 144 021 059 m³ lük serveti (OGM 2022) ile il bazında en yüksek servete sahip bulunmaktadır. Türkiye yüzölçümünün önemli bir bölümünü oluşturan ve önemli bir orman servetine sahip bu alanda ormancılık faaliyetlerinin yürütülebilmesi için ormanların işletmeye açılması gerekli olup, bu durum orman yollarının planlanmasını ve yapılmasını zorunlu hale getirmektedir.

Çalışma alanı olarak seçilen Kastamonu ili Türkiye'nin kuzeyinde Batı Karadeniz Bölgesinde yer almaktadır. Kastamonu ilinin doğusunda Sinop, batısında Bartın ve Karabük, güneyinde Çankırı ve güneydoğusunda Çorum illeri ile sınırı bulunmaktadır. İlin kuzey kısmının tamamı ise Karadeniz'e kıyı oluşturmakta olup, ilin sahil şeridi uzunluğu 170 km olup Karadeniz'e en uzun kıyısı olan il konumundadır. 13.108 km² alan üzerinde yer alan Kastamonu, Türkiye topraklarının %1,7'sini oluşturmaktadır. İl merkezinin denizden yüksekliği 780 metredir. İlin ortalama olarak deniz seviyesinden yüksekliği 775 m'dir. İlin en yüksek noktasını ise 2.565 m ile Çatalılgaz Tepesi oluşturmaktadır.



Şekil 1. Çalışma alanı

KAVRAMSAL ÇERÇEVE

Orman yolu, ormanın her alanında, sürekli ve sürdürülebilir şekilde elde edilen ürünün öncelikle hammadde olan odunun elde edildiği alandan, işlenip değerlendirileceği mekana kadar, en minimal yöntem ve iktisadi şekilde transportunu sağlayan yapılar olarak tanımlanmaktadır (Tavşanoğlu, 1973).

Erdaş (1986) ise orman yolunu, “ormanların işletmeye açılmasına hizmet eden, lastik tekerlekli araçların bütün yıl nakliyat yapmasına yönelik, orman içi ile orman dışı bağlantıyı sağlayan tek şeritli yollar” olarak ifade etmektedir.

Orman yolları ile ormanda üretim işlerine başlarken diğer taraftan da odun hammaddesi, işletme çalışanları ile işçilerin, gerekli olan alet ve ekipmanların taşınmasına, orman civarında yaşayanların ulaşım ihtiyaçlarını ve ayrıca eğlence, spor, dinlenme gibi ihtiyaçlarının giderilmesine imkân sağlamaktadır. Sonuç olarak, orman yolları, iktisadi, sosyo-ekonomik ve kültürel yarar sağlamaktadır (Seçkin, 1982).

Orman yolları, geniş bir alana sahip olan ormanın üretimden elde edilen ürünün transportunu sağlayacak olan makul tesislerden biri olup planlanması ve tesisini yapmak için sadece inşaat tekniği yöntemlerinin yapılmasının yeterli olmadığı, orman işletmesinin tüm özellikleri üzerinde bilgi sahibi olarak yapılması gereken teknik özellikli mimarilerdir (Tavşanoğlu, 1955).

Orman yolları, ormanlardan üretimin başlamasını sağlayan, koruma, silvikültürel ve odun hammaddesi elde etmek, elde edilen ürünün kullanıcıya kadar ulaştırılmasını sağlayan, çalışanları teçhizat ile malzemelerin orman içine ulaştırılmasını sağlayan tesislerdir. Hatta orman yolları gibi ormanları üretime açan yapılar, yangın gibi diğer doğal afetlerin de oluşması durumunda bu afetlere hızlı bir şekilde müdahale zamanını sağlayan yapılardır (Bayoğlu, 1969). Balcı (1996) orman

işletmelerinde yürütülen üretim ve rampaya taşıma işlemlerinden sonra rampa yerlerinden elde edilen tüm ürünlerin transportu için orman yollarının var olmasının zorunluluğunu anlatmıştır.

Orman yolları yapımı; “Bir orman topluluğunun entansif olarak işletilmesi için ekim, dikim, bakım, kesim, hastalık ve zararlılarla mücadele, yangınlardan korunma veya yangınları söndürme gibi çeşitli ormancılık hizmetlerinin zamanında, yöntem ve tekniğine uygun olarak yapılabilmesi ve ormanların çok yönlü fonksiyonel faydalarının hizmete sunulması için yapılacak orman yol ağı planlarını düzenlemektir” (OGM, 2008).

Orman yolları koruma, üretim, bakım gibi birçok ormancılık faaliyetinin gerçekleştirilmesi için hizmet sağlamakta olup, yeni orman yollarının yapılması, yapılan orman yollarının ulaşım elverişli tutulabilmesi için ihtiyaç duyulan üst yapı ve sanat yapılarının yapımı, bakım-onarımı ile standart dışı orman yollarının standart hale getirilebilmesi amacıyla gerçekleştirilen çalışmalar her yıl hazırlanan programlar çerçevesinde yürütülmektedir (OGM, 2016).

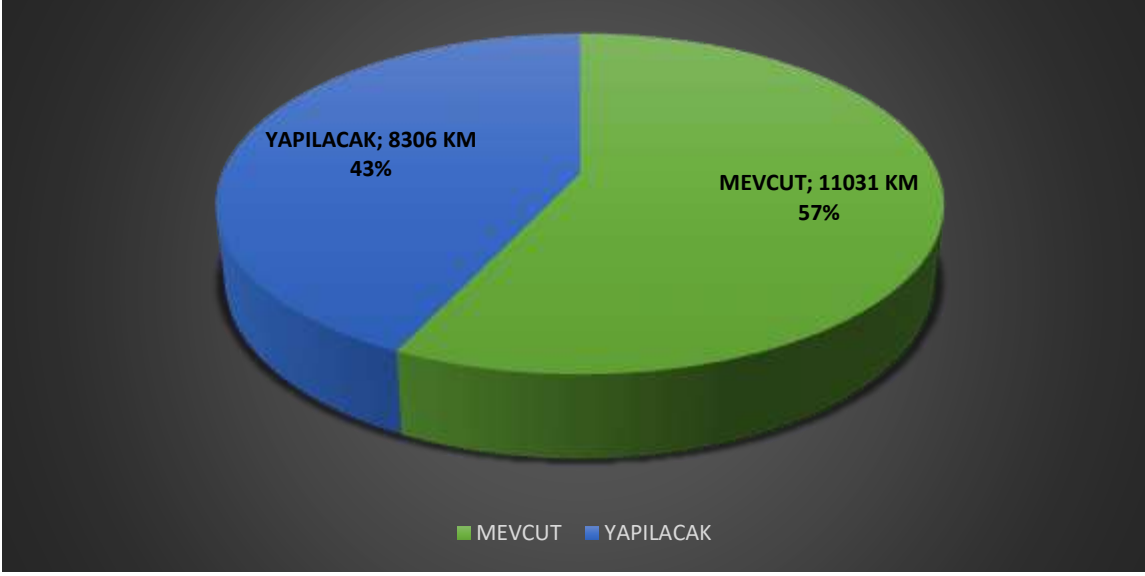
Orman yolları için çeşitli tanımlamalar yapılmış olup genel olarak orman yollarını; ormanların işletmeye açılmasına ve ormanların çeşitli fonksiyonlarının yerine getirilmesine hizmet eden bakım, koruma, üretim faaliyetlerinin yanında araç, gereç ve teçhizat taşınmasına imkan sağlayan ve diğer karayollarına bağlantı sağlayan genellikle tek şeritli toprak yollar olarak tanımlayabiliriz. Tek şeritli olmasının nedeni yol inşaa maliyetlerinin düşürülmesinin yanında doğaya minimum müdahale yapılmasıdır. Çünkü orman yolları orman ekosistemi içerisinde inşa edilmektedir. Bu nedenle ekosisteme olan etkinin mümkün olduğunca azaltılması amaçlanmaktadır.

METODOLOJİ

Çalışma kapsamında Kastamonu Orman Bölge Müdürlüğü plan verilerinden, Orman Genel Müdürlüğü resmi internet sitelerindeki bilgi ve belgelerden, Kastamonu Orman Bölge Müdürlüğü personelinden alınan bilgi ve belgelerden, çalışma konusu ile alakalı yapılmış yüksek lisans ve doktora tez çalışmalarından, ulusal ve uluslararası yayınlardan materyal olarak faydalanılarak gerekli analizler yapılmıştır.

SONUÇ VE TARTIŞMA

Orman yollarının planlanması ve yapımı Orman Genel Müdürlüğü tarafından yayımlanan 292 sayılı tebliğ ile düzenlenmiştir. Bu tebliğ hükümlerine göre, orman yollarının kapladığı alanlar, planlandıkları orman alanlarının % 1'ini geçemez. Bu değer geleneksel hesaplama yöntemine göre 20 m/ha'a karşılık gelir. Kastamonu ili ormanlık alanı 876314 ha olup, en fazla olması gereken orman yolu geleneksel hesaplama yöntemine göre 20 m/ha'a $20 \times 876314 = 17526280$ m = 17526 km hesaplanmaktadır. Kastamonu Orman Bölge Müdürlüğü ile yapılan görüşmelerde ise Kastamonu ilinde planlanan orman yolu ağı uzunluğunun 19337 km olduğu öğrenilmiştir. Bu planlamaya göre hedeflenen yol ağı uzunluğuna erişilebilmesi için 8139 km yeni orman yapılması gerekmektedir.



Şekil 2. Kastamonu Orman Bölge Müdürlüğü Mevcut ve Planlanan Orman Yolu Durumu

Yapılması gerekli olan yeni orman yolları için önceki yıllarda yapılmış olan orman yolları yapım maliyetlerinden yola çıkarak 1.232.448.075 TL yapım maliyeti hesaplanmıştır. Kastamonu ilinin yıllık ortalama tomruk üretimi 600.000 m³ olduğu ve 2024 yılı ortalama tomruk satış fiyatı ise 4116 TL olduğu tespit edilmiştir. Kastamonu ilinden yapılan tomruk satış gelirinin 2024 yılın için ortalama 2.469.600.000 TL olacağı düşünülmektedir. Bu kaynak Kastamonu ili için yapılması planlanan yeni yol yapım maliyetinin yaklaşık 2 katı tutarda olup kaynak sorunu yaşanmayacağı düşünülmektedir. Ayrıca planlanan yolların tamamlanması ile yol yoğunluğu artacak, üretim faaliyetleri kolaylaşacak ve üretim miktarı istenildiğinde artırılabilir. Mevcut bulunan 11031 km yol ile yıllık 600.000 m³ üretim yapılmakta iken planlan yolların yapılması ile üretimin yıllık 1.000.000 m³'ün üstüne çıkarılabileceği ve daha fazla satış geliri elde edileceği düşünülmektedir. Ancak her ne kadar kaynak konusunda sorun yaşanmayacağı düşünülse de planlanan yeni yol yapım çalışmalarının yıllara yayılarak yapılması ve doğaya sert müdahalelerden kaçınılması gerektiği düşünülmektedir. Ayrıca yeni yol yapım faaliyetlerinin bu alanda deneyimli Orman Mühendislerince yürütülmesi gerektiği düşünülmekte olup planlanan yeni yol yapım işlemlerinin kısa zamanda yapılmaya çalışılması teknik personel iş yoğunluğunu kapasite üstünde artıracığı için faaliyetin yıllara yayılarak gerçekleştirilmesi gerektiği düşünülmektedir.

Her yıl yapılacak yeni yol planlamasının %5 artırılmasının uygun olacağı bu oranın yakalanması durumunda yaklaşık 20 yıllık süre zarfında planlanan yeni orman yolu uzunluğunun tamamlanacağı öngörülmektedir.

Kastamonu ili önemli doğal güzelliklere, tarihi ve kültürel değerlere sahip bulunmaktadır. Milli Parklar, Kanyonlar, Anıt Ağaçlar, Orman Parkları vb. birçok kaynağa sahip bulunan ilin son yıllarda turizm potansiyeli ön plana çıkmakta olup bu alanda çalışmalar yapıldığı görülmektedir. İldeki kaynak değerlerinin büyük çoğunluğu ormanlık alanlarda bulunması nedeniyle ulaşım için de orman yolları kullanılması zorunluluğu ortaya çıkmaktadır. Orman yolları sadece ormancılık faaliyetleri için değil turizm rotalarına, orman köylerine ulaşım için gibi farklı amaçlar içinde kullanılmaktadır. Bu nedenle orman yolları yapımında İl Özel İdaresi ve Belediyelerinde rol alması ihtiyaç halinde gerekli ekipman ve kaynak desteğini sağlaması gerektiği düşünülmektedir.

Orman yollarının yapım maliyetlerinin yüksek olması yanında bakım maliyetleri de yüksektir. Bu nedenle orman yolu çalışmalarının bu alanda uzman personelce yapılması ve amacın sadece orman yolu yapmak olmaması gerektiği, yapılan orman yollarının uzun yıllar kullanabilecek şekilde tasarlanması bu amaçla sanat yapılarına önem verilmesi eksik sanat yapılarının ivedilikle tamamlanması gerektiği düşünülmektedir. Sanat yapılarının doğru planlanması ile sel ve taşkın zararlarının orman yolları üzerindeki olumsuz etkilerinin azalacağı böylece yıllık yapılan bakım çalışmalarının azalacağı ve kaynak tasarrufu sağlanacağı düşünülmektedir.

Orman yollarının inşası geriye dönüşü mümkün olmayan sonuçlar doğurmaktadır. Bu nedenle planlamanın kesinlikle konusunda uzman çevre, orman, havza, sel ve çığ kontrolü konusunda tecrübeli personelce yapılması ve çevreye verilen zararın minimum tutulması için gerekli çalışmalar koruyucu bir yaklaşımla titizlikle planlanmalıdır.

Kastamonu OBM Orman yolu yapım işlemlerinin büyük çoğunluğunun ihale ile özel sektöre yaptırıldığı öğrenilmiştir. Bu konuda çalışma yapılarak Kastamonu OBM makine parkının güçlendirilmesi ve orman yolları yapım işlemlerinin kurum tarafından yapılması böylece yıllar geçtikçe bu alanda daha tecrübeli orman mühendisleri, teknik personel ve makine operatörü yetiştirilebileceği düşünülmektedir. Tecrübeli personel sayısı arttıkça da planlamanın ve yol kalite standartlarının artacağı düşünülmektedir.

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USE OF SMALL ZEBRAFISH IN OBESITY DISEASE MODEL

OBEZİTE HASTALIĞI MODELİNDE KÜÇÜK ZEBRA BALIĞININ KULLANIMI

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ÖZET

Zebra balığı (*Danio rerio*) erişkinleri, birbirini izleyen parlak siyah ve gümüş çizgilere sahip, 4-5 cm boyutlarında küçük bir vücuda sahip, tropik sularda yaşayan bir omurgalıdır. Doğal yaşam alanlarında avcılardan kaçmak için su dibinde ve genellikle durgun veya yavaş akan sularda yaşamlarını sürdürürler. Zebra balıkları günümüzde model organizma olarak yaygın şekilde kullanılmakta olup insanlarla fizyolojik, anatomik, genetik ve sosyolojik açıdan oldukça benzerlik göstermektedirler. Bu canlıların tercih nedenleri arasında bakımlarının kolay olması, hastalıklara karşı dayanıklı olmaları ve çok hızlı üremeleri gibi birçok neden sayılabilmektedir. Ayrıca gelişimlerinin çok hızlı bir şekilde 24 saatlik zaman diliminde tek bir hücreden başlayarak bu süre sonunda atan bir kalp, kuyruk ve baş kısımlarının oluşması, sonraki 72 saat süre sonunda beyinlerinin gelişerek gövde ve yüzgeçlerinin oluşması ve beş gün sonunda serbest yüzme yetisine sahip olarak yaşamlarını devam ettirebilmeleri sayılabilmektedir. Bu özelliklerinden dolayı birçok hastalığın seyrinin tanımlanmasında en ön planda olabilecek bir organizma olarak tanımlanmaktadır.

2030 yılında Dünya çapında 1 milyar kişinin, her beş kadından birinin ve her yedi erkekten birinin obezite olacağı bildirilmektedir. Obezite, vücutta aşırı miktarda yağ dokusunun parçalanmasıyla oluşan kronik, kompleks ve geniş metabolik etkilere sebep olan bir hastalıktır. Genellikle genetik, çevresel ve sosyal faktörler sonucu ortaya çıkmaktadır. Ayrıca, uyku düzensizlikleri, yüksek kalorili besin tüketimi ve hareketsizlik gibi etkenler de obeziteye sebep olmaktadır. Kalp, karaciğer, bağırsak ve diyabet gibi hastalıklara sebep olmaktadır. Obezite, her yaş grubunu etkilemekte ve tüm dünyada görülme sıklığı hızla artmaktadır. Ayrıca obezitenin yaygın bir şekilde artış göstermesi ve zebra balığının önemli bir model organizma olması, *Danio rerio*' nun üzerinde birçok obezite çalışması yapılmasına sebep olmuştur. Hastalık patogenezinin iyi anlaşılması, obezite riskinin

önceden keşfedilmesi ve yeni tedavi yaklaşımları için hala pek çok çalışma yapılması gerekmektedir.

Anahtar kelimeler: Hastalık; Model organizma; Obezite; Zebra balığı

Abstract

The adult zebrafish (*Danio rerio*) is a vertebrate living in tropical waters with a small body of 4-5 cm in size, with alternating shiny black and silver stripes. In their natural habitat, they live on the water bottom and often in stagnant or slow-flowing waters to escape predators. Zebrafish are now widely used as model organisms and are physiologically, anatomically, genetically and sociologically very similar to humans. These species are preferred for many reasons, such as their easy maintenance, resistance to disease and rapid reproduction. In addition, their development is very rapid, starting from a single cell in a 24 hour period, followed by the formation of a beating heart, tail and head, the development of their brain in the next 72 hours, the formation of their body and fins, and their ability to swim freely after five days. Because of these characteristics, it is defined as an organism that can be at the forefront of defining the course of many diseases.

By 2030, 1 billion people worldwide, one in five women and one in seven men will be obese. Obesity is a chronic, complex and widespread metabolic disorder caused by the breakdown of excessive amounts of adipose tissue in the body. It is usually caused by genetic, environmental and social factors. It is also known to cause diseases such as heart, liver, intestinal and diabetes, along with factors such as sleep disorders, high calorie consumption and inactivity. Obesity affects all age groups and its prevalence is rapidly increasing worldwide. In addition, the widespread increase in obesity and the fact that zebrafish is an important model organism has led to many obesity studies on *Danio rerio*. Many studies are still needed to better understand the pathogenesis of the disease, to discover the risk of obesity in advance and to develop new treatment approaches.

Keywords: Disease; Model organism; Obesity; Zebrafish

GİRİŞ

Zebrabalığı genel bilgi

İskoç bir doktor olan Francis Hamilton tarafından tanımlanan zebra balığı (*Danio rerio*) Hindistan kökenli bir balık olup biyolojik araştırmalarda en çok kullanılan hayvan modeli olarak günümüzde yer almaktadır (Parichy, 2015; Ferrandino, 2024) (Şekil 1). 1990' larda zebra balığının mutantlarının tanımlanmasıyla birlikte biyolojinin çeşitli alanlarında kullanım için önemli bir balık haline gelmiştir (Rahman Khan, & Sulaiman Alhewairini, 2019). Ortalama 24 – 28 °C sıcaklık aralığında 6.2-8.5 pH değerinde yaklaşık olarak beş yıl yaşam süreleri bulunmaktadır (Lopes-Ferreira, da Rosa, Disner, & Lima, 2024). Zebra balığı çok fazla sayıda yumurta üretme kapasitesine sahip olup gelişimleri çok hızlıdır (Ferrandino, 2024).



Mutluç, Yağcılar, Eser, 2024

Şekil 1. Yetişkin Zebra balığı

Suda gelişim gösteren yumurtalar şeffaf yapıda oldukları için gelişim biyolojisi ve genetik çalışmalar gibi pek çok farklı alanda model organizma olarak kullanılmaktadırlar (Tonon, & Grassi, 2023) (Şekil 2). Zebra balığı ve insan arasında anatomik olarak organlar, yağ dokusu ve omurga gibi oluşumların arasındaki genetik bakımından % 70 denklik ile hastalıkların ilişkisi bakımından ise % 84 oranında benzerlik gösterdiği tespit edilmiştir (Howe vd., 2013).



Mutluç, Yağcılar, Eser, 2024

Şekil 2. Zebra balığı larva görüntüsü

Zebra balığının hastalıklarda kullanılması

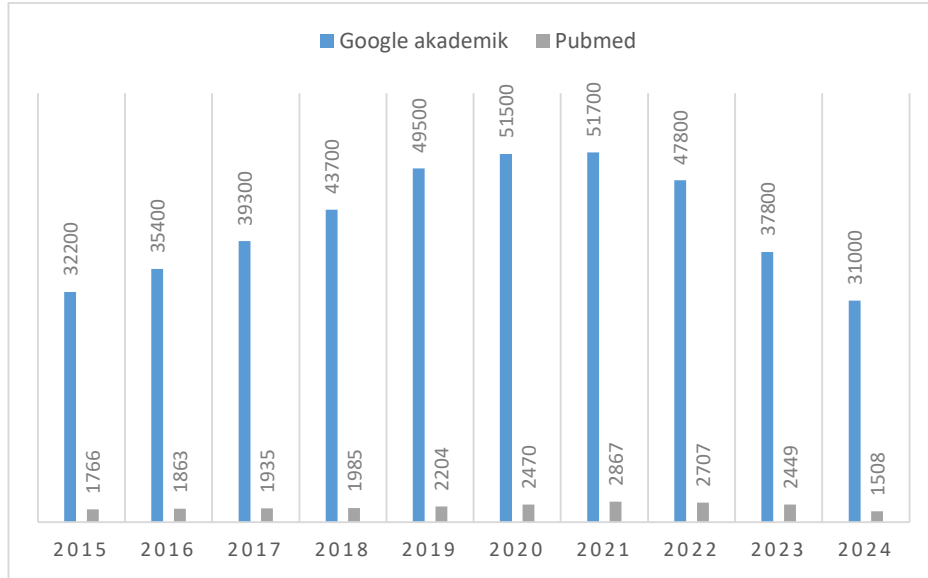
Yüksek yumurta verimi, ekonomik bakım maliyeti düşüklüğü, yetiştirme kolaylığı gibi birçok farklı özelliklerden dolayı günümüzde zebra balığı pek çok farklı alanda kullanılan önemli bir model organizma haline gelmiştir. Zebra balığı toksikoloji, yeni ilaç değerlendirmesi, metabolik bozukluklar, kardiyovasküler hastalıklar, diyabet ve obezite gibi hastalıkların modellenmesinde kullanılmaktadır (Nguyen vd., 2013; Seth, Stemple, ve Barroso, 2013). Aynı zamanda genetik modellenmeler, hematopietik hastalıklar, nöroanatomik ve anatomik bozukluklar, Parkinson, epilepsi, şizofren gibi hastalıklarda da hayvan modeli olarak tercih edilmektedirler (Adhish, ve Manjubala, 2023; Chia, Klingseisen, Sieger, ve Priller, 2022; Lieschke, ve Currie, 2007; Rahman Khan, ve Sulaiman Alhewairini, 2019) (Şekil 3).



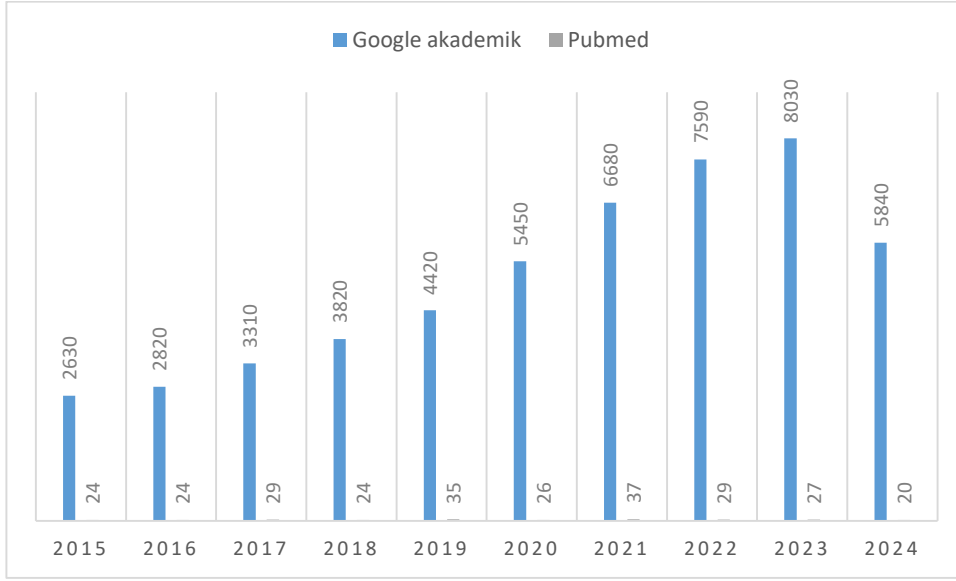
Şekil 3. Zebra balığında hastalık modellenmesi

YÖNTEM

Birçok farklı alandaki araştırmalar için deneysel hayvan modellerinin kullanılmasıyla birlikte günümüzde zebra balığı ile yapılan çalışmalarda yıllık yayın sayısı giderek artış göstermektedir (Şekil 4-5).

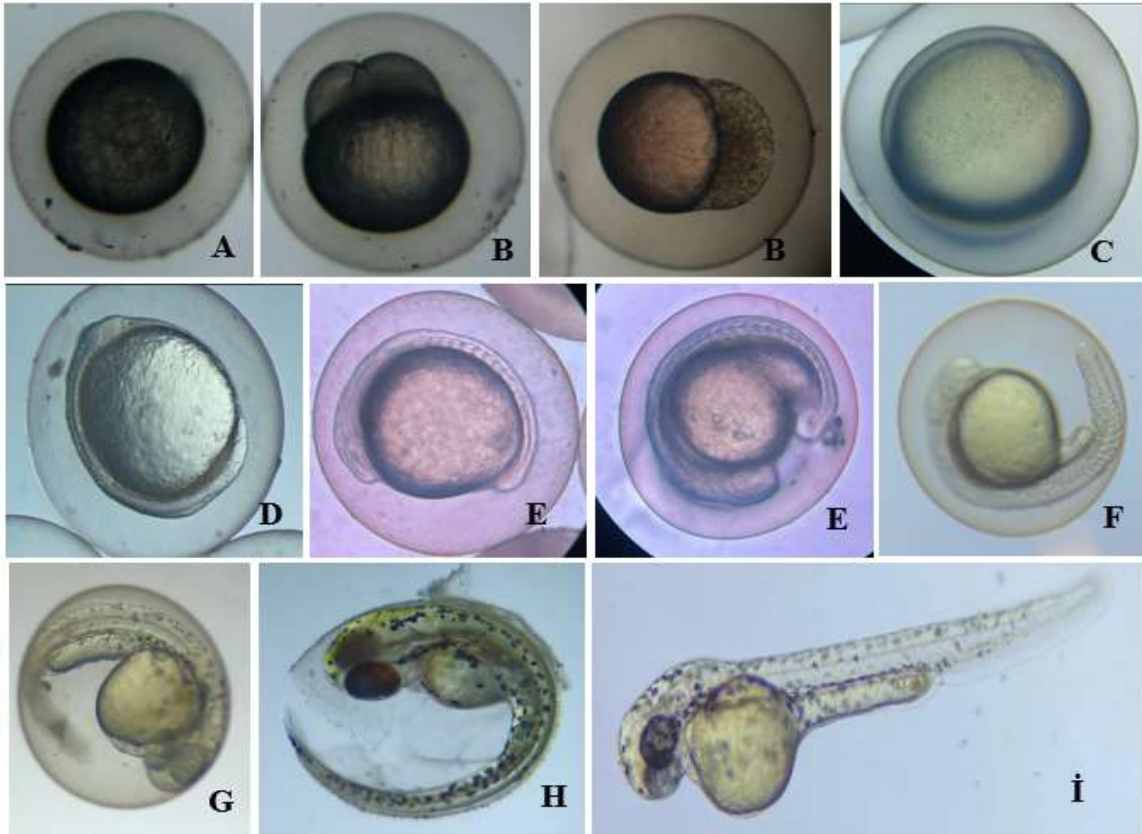


Şekil 4. "Zebra balığı" anahtar kelime ile arama yapıldığında Google akademik ve PubMed'deki yıllık yayın sayısı.



Şekil 5. "Zebra balığı obezite hastalıkları" anahtar kelime ile arama yapıldığında Google akademik ve PubMed' de yıllık yayın sayısı.

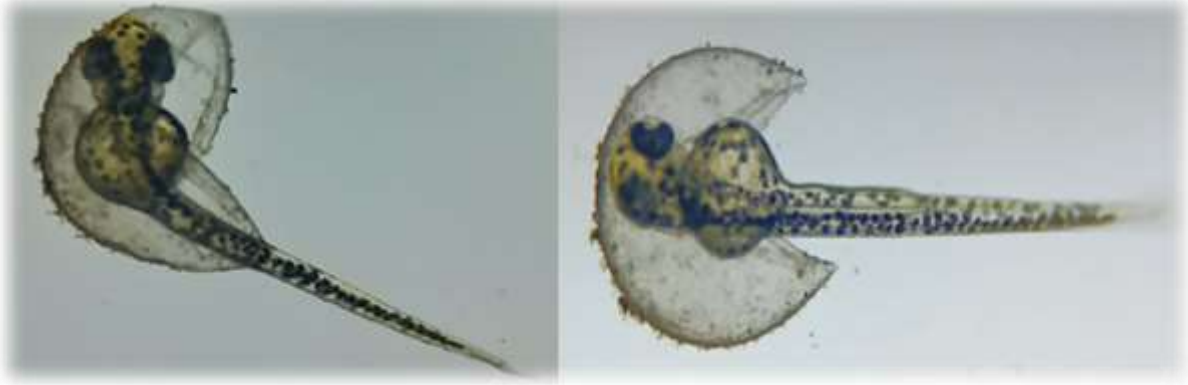
Zebra balıklarında döllenmeden üç gün sonra gerçekleşen embriyo gelişiminin ana safhaları zigot, bölünme, blastula, gastrula, segmentasyon, farengula ve kuluçka dönemleridir (Kimmel vd., 1995) (Şekil 6).



Mutluç, Yağcılar, Eser, 2024

Şekil 6. Zebra balığı embriyo başlıca gelişim evreleri. A, zigot dönemi (0 saat): yeni döllenmiş yumurta; B, blastula dönemi (2 saat); C, gastrula dönemi (5 saat); D, segmentasyon dönemi (10 saat); E, faringula dönemi (24 saat); F, gelişimsel nörotoksisiteyi göstermek için kuyruk kıvrılma sıklığı testi için uygun (36 saat); G, yumurtadan çıkma dönemi (48 saat); H, erken larva dönemi (72 saat); İ, Fotoğraflar; Tekirdağ Namık Kemal Üniversitesi Fen Edebiyat Fakültesi Biyoloji Bölümü Sucul Deney Hayvanları Laboratuvarımızda çekildi.

Bu gelişim safhalarında balastula dönemi döllenmeden sonraki 2 saat (hpf), ilk organ gelişimleri 48 saatte gerçekleşerek 72. saatte larvalar yumurtadan çıkar ve bu aşamada anatomik bozukluklar, ölüm oranları ve safhalardaki gelişim sürelerinin belirlenmesi yapılabilmektedir (Zhao, Chen, Hu, Long, ve Cao, 2024) (Şekil 7).



Şekil 7. Zebra embriyosunun yumurtadan çıkış görüntüsü

Zebra balığında obezite

Obezite günümüzde bir sorun haline gelmiş yağ dokusunun aşırı birikimiyle karakterize olan dünyanın en büyük sorunlardan biri olarak hem çocuklar hem de yetişkinler için tehlike oluşturmakta bu kronik durum, özellikle tip iki diyabet, kardiyovasküler pek çok hastalık ve bazı organ kanserlerine sebep olabilmektedir (Smolińska vd., 2024). Obeziteyi oluşturan genetik, moleküler ve fizyolojik mekanizmaların bilinmesi, bu hastalığın önlenmesi ve tedavi edilebilmesi için etkili yolların geliştirilmesi açısından büyük önem taşımakta ve zebra balıkları ile memeliler arasındaki beslenme fizyolojisi, yağ metabolizması ve enerji dengesi korunması için tedavi yöntemlerinin araştırılması, zebra balıklarının insan obezitesini modelleme açısından önemini vurgulamaktadır (Seth, Stemple, ve Barroso, 2013; Tonon, ve Grassi, 2023; Tainaka vd., 2011). Obezitenin altında yatan genetik, aşırı yağ tüketimi ve stres gibi faktörlerin ortaya çıkarılması ve bazı ilaçların denenmesi için pek çok çalışma yapılan zebra balığı, ileride de pek çok çalışma için umut oluşturabilmektedir (Seth, Stemple, ve Barroso, 2013; Tonon, ve Grassi, 2023; Tainaka vd., 2011). Örneğin Zhang ve ark. tarafından yapılan çalışmada zebra balığı kullanılarak β -sitosterolün önemli lipid ve kolesterol düşürücü etkisi olan doğal bir ürün olduğu anlaşılmış, zebra balıklarındaki lipidlerin gözlemlenmesi sayesinde, β -sitosterolün zebra balıklarında trigliserit ve kolesterol birikimini azaltabildiğini ve yüksek şekerli ve yüksek yağlı diyetin neden olduğu ilgili fenotipik değişiklikleri azaltabildiğini ve böylece zebra balıklarında lipid birikimini azalttığı tespit edilmiştir (Zhang vd., 2024). Aynı şekilde Al jaber ve ark. göre zebra balıklarında yapılan çalışmada safran ekstraktının anti-obezite etkileri incelenmiş ve yüksek yağlı diyet içeren beslenme şeklinde zebra balığı modelini kullanılarak bu bitkinin basit bir hayvan modelinde obeziteyi nasıl azalttığına dair yeni bir bakış açısı sunmuştur (Al Jaber, Alhawarri, Dewa, Zainal, ve Zakaria, 2024).

Martins ve ark. yaptığı çalışmada, zebra balıklarını obezite ve fiziksel egzersiz ile ilgili araştırmalar için deneysel bir model oluşturmayı ve bu fiziksel faktörlerin metabolizma üzerindeki etkilerini değerlendirmeyi amaçlamış ve deney on iki hafta sürmüştür, son dört hafta fiziksel bir egzersiz protokolü uygulanmıştır. Bu protokolda, on beş hayvanın beş litrelik bir akvaryuma yerleştirilmesi ve burada günde 30 dakika boyunca yaklaşık 0,08 m/s hızla yüzmeye tabi tutulmuştur. Böylece fiziksel egzersizin zebra balıklarında obezite üzerinde olumlu bir etkiye sahip olduğunu ve bu alanda gelecekteki araştırmalar için umut verici kanıtlar sağladığını göstermiştir (Martins vd., 2024).

SONUÇ VE TARTIŞMA

Birçok çalışma, obez zebra balıklarının metabolik yolları ile memeli obezitesinin metabolik yolları arasında benzerlikler bulmuştur. Oka ve arkadaşları diyetle ilgili bir obezite zebra balığı modelinin memeli obezitesi ile patofizyolojik mekanizmaları paylaştığını keşfetmiştir. Pankreasın yapısı ve işlevleri, yağ dokusu, lipid metabolizması ve glukoz homeostazı ile insanlarla olan benzerlikler nedeniyle, zebra balığı, çeşitli metabolik bozuklukların incelenmesi için çekici bir hayvan modeli olarak kemirgen modellerinin yerini almaya başlamıştır. Obez zebra balıklarının insanlara benzer kardiyovasküler aşırı yük değişikliklerine sahip olduğu gösterilmiştir.

Zebra balığının, insanlarda obezite ile ilgili çeşitli hastalıkların araştırılmasında memeli obezitesi için etkili bir model olduğu kanıtlanmıştır.

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**COMPARISON OF BIOLOGICAL ACTIVITIES OF ETHANOL AND AQUEOUS
EXTRACTS OF BRACTS OF *BOUGAINVILLEA GLABRA***

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ABSTRACT

Bougainvillea is a tropical and subtropical woody vine that makes excellent attractive horticulture plants because of its colorful bracts, long flowering season, and strong stress tolerance. *Bougainvillea glabra*, which belongs to the family Nyctaginaceae, is often used as a decorative plant. Recent research shows *Bougainvillea* may possess anti-inflammatory, anticancer, antibacterial, antihyperglycemic, and antioxidant properties. This study aimed to compare the antibacterial and cytotoxic activities of ethanol and aqueous extracts of bracts of *Bougainvillea glabra*. To analyse the bioactivity of this plant, the collected bracts of *B. glabra* were air-dried and ground into small pieces using a grinder. The plants were extracted for 24 hours using ultrasound treatment with 100% ethanol and water separately. The *in vitro* cytotoxic effects of extracts were examined for a 72-hour in MDA-MB-231 (triple-negative breast cancer cell line) and SH-SY5Y (neuroblastoma cell line). In addition, the disk diffusion and minimum inhibitory concentration (MIC) methods were utilized to determine the antibacterial activities of these extracts. As a result of *in vitro* cytotoxicity test, IC₅₀ values of ethanol extracts of bracts of *B. glabra* were 4035,67 ± 195,22 for MDA-MB-231 cells and 3035,67 ± 151,14 for SH-SY5Y cells. On the other hand, the IC₅₀ values for aqueous extract could not be calculated for two cell lines because it was outside the studied range. In addition, tests for antibacterial activity have given significant results on tested bacteria. The ethanol extract of bracts of *B. glabra* was found to be more effective than aqueous extract based on antibacterial and cytotoxic activity tests. The current study has demonstrated that bracts of *B. glabra* have potential for both anticancer and antibacterial activities. Additional studies are required to investigate further medicinal properties.

Keywords: *Bougainvillea glabra*, Extraction, Antibacterial, Cytotoxicity.

INTRODUCTION

Ancient societies have used plants in traditional medicine to treat various diseases (Saleem et al., 2019). Studies by the World Health Organisation (WHO) have revealed that more than 80% of the world's population still relies on traditional medicine for important health purposes (Abarca-Vargas et al., 2016). Furthermore, because synthetic drug resistance mechanisms limit their application (Joshny et al., 2013), the current approaches has been focused on determining the biological activity of compounds isolated from plants (Saleem et al., 2019). In addition, WHO recommends its use due to their low cost, public acceptance and fewer side effects. Plants produce secondary metabolites to perform various metabolic functions (Joshny et al., 2013). These metabolites, especially phenolic and flavonoids, support alternative treatment processes on the living organisms with the different compounds they contain (Saleem et al., 2021).

Bougainvillea glabra is one of the 14 known species of the genus *Bougainvillea* (Ogunwande et al., 2019) belonging to the Nyctaginaceae family (Saleem et al., 2019). This plant, which is native to South America (Kuhn et al., 2020; Ornelas Garcia et al., 2023), was first discovered in Brazil by Louis de Bougainville in the 18th century (Saleem et al., 2021). It is also popularly known as 'Paper Flower' or 'Glory of the Garden' (Saleem et al., 2019) and is frequently used as an ornamental plant (Saleem et al., 2021). *B. glabra*, which grows frequently in tropical and subtropical regions, is observed in evergreen and bush or climbing form (Saleem et al., 2021). It usually has spiny stems and grows up to 3.7 m in height (Abarca-Vargas and Petricevich, 2018; Ogunwande et al., 2019).

Compounds obtained from *B. glabra* bracts are known to have potential for use in the food, cosmetic and pharmaceutical sectors (Kuhn et al., 2020). This plant has been utilized in traditional medicine for the treatment of gastrointestinal problems as well as respiratory diseases (Joshny et al., 2013; Abarca-Vargas and Petricevich, 2018). They exhibit antioxidant, antimicrobial, anti-proliferative, cardioprotective, anti-diarrhoeal, anti-ulcer, anti-inflammatory, anti-hyperglycaemic agent and insecticidal properties owing to their secondary metabolites (Saleem et al., 2019; Ogunwande et al., 2019; Kuhn et al., 2020). *In vitro* anticancer activity against Hela cell lines have recently been demonstrated (Ogunwande et al., 2019). The main components found in *B. glabra* are betacyanins, flavonoids, tannins and alkaloids (Saleem et al., 2021). In addition, compounds such as terpenoids, glycosides and essential oils have been identified (Joshny et al., 2013). In the bracts of *B. glabra*, kaempferol, p-coumaric acid, myricetin, and synapic acid are intensively found phenolic compounds (Kuhn et al., 2020). The plant is known to contain betaxanthin, a natural pigment and oleananoic acid acetate (Ogunwande et al., 2019).

Betacyanin and betaxanthin, which describe betalain pigments, are betalamic acid derivatives. These pigments are responsible for the colour diversity of *B. glabra* (Ornelas Garcia et al., 2023). Betacyanin is the pigment that imparts the purple colour, while betaxanthin produces the yellow-orange colour. It is known that betacyanin content is effective in the intensity of purple colour in *B. glabra*. Analyses showed that *B. glabra* has more than 30 betacyanin molecules (Abarca-Vargas and Petricevich, 2018; Kuhn et al., 2020).

In this study, ultrasound-assisted extraction of *B. glabra* bracts collected during the flowering season was performed and the cytotoxic and antibacterial activity of the ethanol and aqueous extracts were evaluated.

METHODOLOGY

Extraction of *B. glabra* bracts

B. glabra plants, whose bioactivities were to be measured, were collected during flowering and the bracts were air-dried. The dried bracts were ground into small pieces with a commercial mill. The grinded 1 g of *B. glabra* bracts were extracted in 10 ml each of 100% ethanol and water, separately. Ultrasound-assisted extraction was performed in an ultrasound bath (Alex Machine, Turkey) for 24 hours. After extraction, the samples were centrifuged at 3000 rpm for 15 min and the supernatant was separated into a sterile tube for bioactivity assays.

In vitro Cytotoxicity Assay

For cytotoxicity assay, MDA-MB-231 and SH-SY5Y cells were grown in Dulbecco's modified Eagles' medium (DMEM) (Gibco, MA, ABD) supplemented with 10% Fetal bovine serum (FBS) (Gibco, MA, ABD), 1% L-glutamine (Gibco, MA, ABD) and 1% penicillin/streptomycin (Gibco, MA, ABD) at 37°C in 5% CO₂ humidified atmosphere.

The cytotoxicity of the extracts was analyzed by MTT (3-[4,5-dimethylthiazole-2-yl]-2,5-diphenyltetrazolium bromide) (Sigma) assay against triple-negative breast cancer cell line (MDA-MB-231) and neuroblastoma cell line (SH-SY5Y) depended on *in vitro* cytotoxicity and cell viability. For this purpose, the viable cells at exponential growing phase, were counted by trypan blue and seeded into 96-well plates at 1×10^4 cells/well initial concentration. After overnight incubation of cells at 37°C with 5% CO₂, the extracts were treated to the cells 2-fold dilution between 125 to 8000 µg/mL concentration. Then, well plates were incubated for 72 hours. Following incubation, 10 µl of MTT reagent (dissolved in PBS (Gibco)) was applied to each well. After that, the wells were incubated for a further 3.5 hours. After the incubation period, 100 µl of DMSO (dimethyl sulfoxide) (Merck) was added to each well after the MTT and medium was withdrawn. The formation of formazan in the wells was determined by measuring the absorbance at 570 nm (Mosmann, 1983; Saleem et al., 2019). The cell viability percentage (%) and IC₅₀ values were calculated by Graphpad Prism Software.

Antibacterial Activity Assay

Antibacterial activities of the extracts were assessed by both disk diffusion and minimum inhibitory concentration (MIC) assay. *Staphylococcus aureus* was used as gram positive bacteria, *Escherichia coli* and *Pseudomonas aeruginosa* were used as gram negative bacteria.

For the Kirby-Bauer disk diffusion method, bacterial suspensions were diluted to an optical density of 0.6 at 600 nm wavelength. The diluted bacteria were inoculated on Mueller-Hinton Agar (Merck, USA) at a concentration of 1×10^6 CFU/ml by the spread plate method. After inoculation, 6 mm diameter sterile antimicrobial susceptibility disks (Oxoid) were impregnated with extracts and the disks were placed on agar. Petri dishes were incubated at 37°C for 24 hours. Antibacterial inhibition zones were determined by measuring the zone diameters around the disks (Singh et al., 2023).

The MIC test was carried out using the microdilution method in 96-well plates. Extracts were diluted two-fold in 96-well plates at different concentration range. Following an overnight incubation period at 37 °C, 5×10^5 CFU/mL of diluted bacteria were added to the extracts. Plates were incubated at 37 °C for 24 hours. After incubation, the absorbance at 600 nm wavelength was measured in a spectrophotometer to obtain the MIC value (Maltaş et al., 2010).

RESULTS AND DISCUSSION

Ethanol and aqueous extracts of *B. glabra* bract were evaluated for *in vitro* cytotoxicity by MTT method. Percent viability values (Figure 1) were determined and IC₅₀ values (Table 1) were calculated and as a result of the tests performed on MDA-MB-231 and SH-SY5Y cells.

As a result of cytotoxicity assays, IC₅₀ values for ethanol extracts were calculated as 4035.67 ± 195.22 µg/ml for MDA-MB-231 cell line, 3034.33 ± 151.14 µg/ml for SH-SY5Y cell line. On the other hand, IC₅₀ values for the water extracts could not be calculated at tested doses. The ethanol extracts have more cytotoxic potentials against triple-negative breast cancer and neuroblastoma cell lines. Moreover, the ethanol extract showed more cytotoxic effects on SH-SY5Y neuroblastoma cell line.

Table 1. IC₅₀ values of ethanol and aqueous extracts of *B. glabra* bracts after 72 hours incubation on MDA-MB-231 and SH-SY5Y cells (µg/ml).

IC ₅₀ (µg/ml)	Ethanol Extract	Aqueous Extract
MDA-MB-231	4035.67 ± 195.22	>8000
SH-SY5Y	3034.33 ± 151.14	>8000

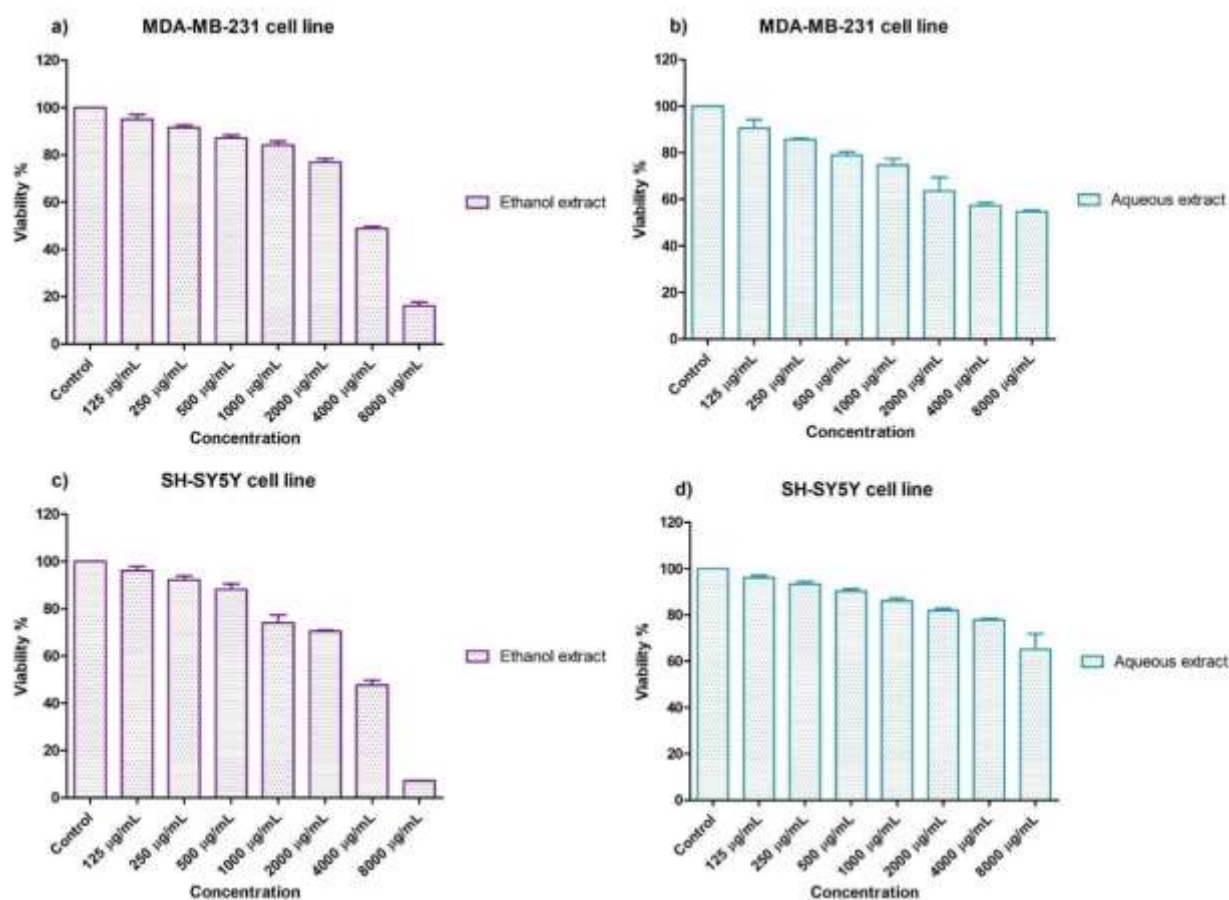


Figure 1. Cell viability values of *B. glabra* a) ethanol extract against MDA-MB-231, b) aqueous extract against MDA-MB-231, c) ethanol extract against SH-SY5Y, d) aqueous extract against SH-SY5Y.

One of the important studies on the cytotoxic activity of *B. glabra* was carried out in HeLa cells. The leaves of the plant were dried and extracted by soxhlet extraction. The extracts were diluted 2-fold between 6.25-100 µg/ml and HeLa cells were treated for 48 hours. As a result of the cytotoxicity test, the IC₅₀ value of the hydroalcoholic extract of *B. glabra* was found to be 47.11 µg/ml (Joshny et al., 2013). In a study, macerations of the aerial parts of *B. glabra* were carried out with dichloromethane and methanol. *In vitro* cytotoxic activity of the extracts was evaluated in breast cancer (MCF-7 and MDA-MB-231) cells, cervical cancer (CaSki) cells, colon cancer (SW-480) cells, and prostate cancer (DU-145) cells. It was determined that both dichloromethane and methanol extracts had IC₅₀ values ranging from 22.09 to 257.2 µg/ml (Saleem et al., 2019). In another study, ethanol extract of *B. glabra* bracts was applied to African green monkey (Vero) kidney cells and fetal human liver cells (WRL 68). The cytotoxicity of extracts was analysed after 72 hours and IC₅₀ values were calculated as 269.10 ± 70.16 µg/ml for Vero cells and 135.46 ± 20.43 µg/ml for WRL-68 cells (Shalini et al., 2018).

The disk diffusion and MIC method were used to analyse the antibacterial activity of *B. glabra* against 3 different bacteria. Zone diameters were determined in disk diffusion assay and minimum inhibition concentrations were calculated in MIC assay (Table 2).

Table 2. Antibacterial activity assay results of ethanol and aqueous extracts of *B. glabra* bracts.

Bacteria	Disk Diffusion Assay		MIC Assay	
	Ethanol Extract	Aqueous Extract	Ethanol Extract	Aqueous Extract
<i>P. aeruginosa</i>	8.4 mm	9.1 mm	6.25 mg/ml	6.25 mg/ml
<i>E. coli</i>	8.5 mm	6.5 mm	6.25 mg/ml	25 mg/ml
<i>S. aureus</i>	8.3 mm	7.6 mm	6.25 mg/ml	12.50 mg/ml

The zone diameters of *B. glabra* ethanol extract were measured as 8.4 mm for *P. aeruginosa*, 8.5 mm for *E. coli* and 8.3 mm for *S. aureus*. The water extract formed zone diameters of 9.1, 6.5 and 7.6 against same bacteria, respectively. The MIC concentrations of the ethanol extract were found 6.25 mg/ml against all bacteria. For the water extract, MIC values were 6.25 mg/ml for *P. aeruginosa*, 25 mg/ml for *E. coli* and 12.50 mg/ml for *S. aureus*. In a study, ethanol extracts of different parts of *B. glabra* were analysed against two gram-positive and two gram-negative bacteria by disk diffusion test. The flower extracts were found to be effective against *E. coli* and *P. aeruginosa* which are gram-negative bacteria, with an inhibition zone of 7 mm (Perales and Leysa, 2012). Enciso-Diaz et al. (2012) obtained ethanol extracts of the aerial parts of *B. glabra* and determined its antibacterial activity by both disk diffusion and MIC test. The ethanol extract of *B. glabra* produced a zone diameter of 13 mm against *S. aureus* and *S. agalactia* and MIC concentrations between 1000-2500 µg/ml were obtained (Enciso-Diaz et al., 2012). In another study, the antibacterial activity of betacyanins obtained from *B. glabra* bracts was analysed against *B. subtilis*, *P. aeruginosa* and *E. coli*. As a result of the disk diffusion test, it was found that betacyanins showed an effective antibacterial activity against *B. subtilis* with a zone diameter of 6.7-7.4 mm (Napoleon et al., 2013). In a study evaluating the antimicrobial activity of *B. glabra*, methanol extraction of the collected flower part was performed and evaluated by disk diffusion method against *S. aureus*, *B. cereus*, *E. coli*, and *P. aeruginosa*. Zone diameters were 17-22 mm for *S. aureus*, 15-16 mm for *E. coli* and 12-14 mm for *B. cereus* (Zahidul et al., 2016).

As can be seen from the studies, both cytotoxic and antibacterial activities are affected by the extraction method, the solvent used in the extraction, the treatment time of the extract, and the type of cell or bacteria used.

CONCLUSION

Tests for cytotoxic and antibacterial activities have shown that the ethanol extract of *B. glabra* bracts was more effective than the aqueous extract. The results of this investigation have indicated that *B. glabra* bracts may have antibacterial and anticancer properties. Testing its antibacterial activity on different bacteria and determining its cytotoxic activity using different cell lines will contribute to the investigation of the potential use of *Bougainvillea glabra* in healthcare field.

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**ANALYSIS OF STARCH LEVEL IN ASPEN TREE *POPULUS TREMULA* LEAVES TO
UNDERSTAND STORAGE MECHANISM IN WOODY PLANTS**

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Abstract

Introduction and Aim: In photosynthetic eukaryotes plants, starch has several functions: It can be used as structure molecule for cell membrane, energy source in the cell, transport molecule to the seed to support next generation, or to the storage organs like root.

In plants there are two types of storage form was observed: Active storage that supports plant growth even the storage pools are not full and passive storage that used the carbohydrates to restores the storage first by suppressing growth than after that plant grows.

The carbohydrate metabolism in higher photosynthetic eukaryotes like plants is a debate for years. First, the mechanism was tried to be understood in model organism *Arabidopsis thaliana*. However, it was suggested that mechanism could be different in woody plants. In this laboratory research the carbohydrate metabolism in woody aspen tree leaves of *Populus tremula* was examined by measuring starch level in day/night cycle and the storage mechanism was tried to be understood.

Materials And Method: *Populus tremula* leaves that grown 18/6 hours day/night period was taken at five different time point and frozen at -80 liquid nitrogen. Leaves were pulverized by using ball mill machine. The level of starch in this leaves that taken from different time points was calculated with starch assay.

Results: The level of starch was quite different at the leaves; it was high at leaves that taken in 18.00 and 21.00 while lowest in the leaves that taken 03.00 at the end of the night.

Discussion and Conclusion: As a result of experiment, we observed that the starch level in the *Populus tremula* leaves changes according to the daily exposure time and based on this data we can conclude that aspen tree has passive storage mechanism that supports growth even there is an interruption in starch/carbohydrate metabolism.

Keywords: *Populus tremula*, starch metabolism, carbohydrate turnover,

**“THE TRAIN IS THE WORLD. WE THE HUMANITY.”: AN ECOCRITICAL
ANALYSIS OF THE SCIENCE FICTION MOVIE *SNOWPIERCER* BY BONG JOON-HO**

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Abstract

With the dominant effect of capitalism and anthropocentric ideology, nature has been figured out as a tool or a mechanism to be controlled by human being. Moreover, science and technology are manipulated to achieve mastery on nature by political and financial powers. As a consequence of this attitude, natural resources have been exploited, and it has born destructive outcomes in ecological perspective. On the purpose of drawing attention to these consequences and avoiding from the possible end of life on earth, science fiction movies prepare a convenient background to reveal the relationship between human and nature and to anticipate the results of human interruption by the help of apocalyptic scenarios. Therefore, this paper attempts to scrutinize the dominant ideology and the possible consequences of human interruption not only on nature but also on humankind represented in the science-fiction movie *Snowpiercer* from an ecocritical perspective. In this regard, the present study shows the instances of damaging nature through science and technology by order of dominant powers and reveals the anticipated consequences leading to the apocalypse. Also it highlights the results of human activities damaging the continuity of human generation besides nature in order to make an inference about the probable solutions to eliminate the destruction on earth.

Key words: Ecocriticism, Apocalypse, Ecological disasters, Science-fiction movie

INTRODUCTION

Throughout history, the indispensable relationship between human and nature has been a hotly-debated issue considering the commanding effects of human being on nature. It is obvious that they always have a tendency to wield nature and natural resources not only to survive but also to manipulate it for their benefits both politically and financially. With the increasing numbers in population and renovations in the field of science and industry, human being causes irreversible destructions on both nature and human generation because they have ignored the fact that they are a part of ecosystem and that they need nature to survive (Şen, 2018). It is clear that dramatic loss and contamination of natural resources reaches a hazardous point for ecosystem while people are in a tendency to increase their profit by exploiting both nature and the ones from lower classes. Moreover, the increasing rates of deforestation, the disastrous consequences caused by over-contamination of water, and significantly unpredictable outcomes of technological and scientific developments has led human being to consider the scenarios about the end of life on earth. Not surprisingly, they attempt to draw attention to the anticipated consequences of human activities by means of ecocriticism as a literary theory, which paves the way to probe into the details related to interaction between human beings and nature through both literature and various artistic disciplines including films. Therefore, this study aims to reach an ecocritical analysis of *Snowpiercer*, a science-

fiction movie taking place in a dystopia portraying the extreme conditions caused by the exploitation of nature by humankind.⁷

Snowpiercer talks about human life trapped in an enormous train, which is a marvel of technology and the only way for the survival of human generation in the frozen world for eighteen years. Initially, scientists, who are seeking for solutions to overcome global warming, make use of CW7 a dangerous chemical to cool down the world. Unfortunately, they cannot foresee the destructive effects of technology before freezing the world to the core. While all organisms in the world including human, animals, and plants become condemned to freeze, a group of people manage to survive by the help of a train which is invented to create an ecosystem for the continuity of human generation. What makes the train invaluable is the eternal engine, and it has to complete its circle throughout the world in a year without stopping. The train not only includes residences and stations for human to live but also has an aquarium, cattle, and a greenhouse to use for the continuity of human. However, the newly-created world on the train hosts class discrimination, racism, and exploitation of both nature and people.

The overall structure depicted in the movie portrays apocalyptic visions related to the continuity of generation in the world as a consequence of seeing financial power as utmost, maltreatment of people and nature, and exploiting the world through science and technology. It is obvious that the initial aim of this movie is to draw attention to the role of governments and global companies which have the greatest financial power on the ecological destruction in the world besides catastrophic results caused by the excessive use of science and technology on the world. Therefore, *Snowpiercer* presents ambivalent examples in order to analyse the dystopia including the apocalyptic elements within its causes and effects, and also it sheds light on the fact that economic and political power is to be taken into consideration to deal with ecological disorders and destructions. From an ecocritical perspective, it not only represents the causes of the natural disasters including human understanding of nature, but also gives glimpses about the solution to defeat the apocalyptic outcomes of ecological catastrophes.

CONCEPTUAL FRAMEWORK

Upon the destructive impacts of human activities on earth, people attempt to draw attention to the jeopardized situation of the world and human generation and also to seek for solutions to reverse the negative effects destroying nature. However, the results presented in numbers, rates, and statistics are not seen as adequate to motivate people in order to find reasonable answers. Therefore, the term Ecocriticism, which is coined by William Rueckert for the first time to discover the connection of ecology and literature, functions as a central role in order to usher people to study and focus on the relationship and interaction between human and nature through literature (Glotfelty, 1996). As Oppermann states, numerical symbols, numbers, and charts do not affect or encourage people to protect nature; however, narratives are the key to reach human consciousness (2009). In other words, ecocriticism works as a mean to make people realize the destructive outcomes of human deeds on nature through literature. It is important to know that as a literary theory, ecocriticism comprises a wide variety of products from different disciplines, includes cultural issues, and questions the human understanding and perception of nature as the real subject in today's world. Moreover, by addressing to human nature, ecocriticism aims to create a collective consciousness about interconnectedness and interdependence with nature (Şen, 2018).

⁷ *Snowpiercer* is a science-fiction movie directed by Bong Joon-Ho in 2013.

Apparently, the deterioration of the world is also thought closely connected to the apocalypse as ancient cultures and religions envision throughout centuries. Not surprisingly, it leads to coin the term Apocalypticism, as a genre which comes out of crisis and chaos and deals with the problems about the end of the world. It is significant to note that narratives including apocalyptic details are closely connected to ecological discourses because the ideas raised from Apocalypticism are basically works of imagination, and they provide humanity to anticipate the possible destructions in environmental and ecological respect (Garrard, 2012). Therefore, it gives humanity a chance to figure out the problems related to nature as a reminder of the apocalypse and to take precautions before it is too late. In this respect, science-fiction movies, which are generally about the end of the world, open a gate to consider human activities towards nature and humankind in extreme circumstances. It is also important that while it is hard to figure out the damage rates on nature caused by human, films in this genre give possibility to imagine the further aspects of destruction in the future (Şen, 2018). As Easterlin highlights, literary works should be taken as the products of human mind directed to the other humans' consciousness (2004). When the science-fiction scenarios are categorized as a kind of literary work, they need to be articulated as a reflection of human mind and as an opportunity to infer the overall message behind the scenes.

In the realm of ecocriticism, Garrard states that details related to the apocalypse should be taken into account to overcome the environmental disasters (2012). At the beginning of the list, it is crucial to envision that dangerous chemicals used to control the nature prepare the anticipated scenarios about the end because they contaminate water, air, and land irreversibly. As Carson also suggests, the contamination of the earth in each respect is the most threatening deed to deteriorate the world; and unless the necessary precautions are considered, a human-made apocalypse seems inevitable (1999). In addition to the use of chemicals, increasing human population is seen as the other important apocalyptic issue because it is possible to lead the world into famine. However, Garrard puts an emphasis on that the foreseen disaster related to famine seems to be an attempt to decrease human population, controlled by political, military, and economic powers rather than a natural process (2012). In a broad perspective, it is crucial to realize that human being is only a part of nature, and every attempt to control and overcome it causes imminent and unanticipated catastrophes not only for nature but also human generation.

Consequently, ecocriticism as a theory serves as a central role to realize the ongoing hazards on nature caused by human and to anticipate the probable disasters designed by governments and economic forces unintentionally. At this point, considering the notion of the apocalypse can be seen as helpful to illustrate and foresee the jeopardized status of nature and human in environmental and ecological perspective. Also, different genres including literary texts and movies assist to visualize the upcoming threats and to minimize the tragedy. Therefore, with abundant examples of apocalyptic issues, the science-fiction movie *Snowpiercer* will be analysed in an ecocritical perspective to assume the possible solutions to elude the human-made catastrophe.

DISCUSSION

Considering environmental and ecological issues, science-fiction movies, which generally talk about natural disasters inducing the extinction of humanity, mirror the reasons behind the disasters and solutions to defeat them besides providing people with an understanding over the relationship and dependency between nature and human being. In this respect, *Snowpiercer* has presented numerous instances encapsulating apocalyptic visions, nature in dystopia, human being's desire to prove mastery over nature, and outcomes of ecological disruptions represented in a devastating manner. In an ecocritical analysis, the movie gives a chance to realize the destructive effects of

human activities on nature and to seek for solutions to prevent them by witnessing the represented version of the apocalypse through a science-fiction scenario.

At the onset of the plot, the world suffers from global warming, and scientists apply a chemical into the atmosphere to cool it down as an act of state. However, their attempt resulted in a disaster and causes to freeze the world until every organism dies on it. Wilford, who is an engineer foreseeing the disaster, invents an enormous train with a perpetual engine. It is designed to complete its one cycle in a year throughout the world without stopping. What makes the train significant is also to have an ecosystem in it including animals and plants to consume besides commodities for passengers to maintain their lives. Unfortunately, class distinction and exploitation of nature become the major problems on board. While rich people, who are basically the cause of the disaster, live in glory in the first compartments, thousands of people have to live in misery without food or care in the tail part of the train. Therefore, after eighteen years, they plan to revolt to take the control of the train and live properly. After fights and loss of lives in great numbers, Curtis, the head of the rebel, reaches the engine where Wilford lives. Surprisingly, he learns that all things related to the revolt have been planned by Wilford to reduce the population because of the decrease in supply and to find a successor for the head position because of Wilford's old age. However, Curtis feels deceived after finding out the truth and disappointment about their prospect. A father and his daughter, helping him to reach the engine, cause an accident, and the train is broken into pieces. Only the daughter and a little boy survive. Finally, they discover that the temperature is reaching the convenient degrees for human to live and see a polar bear on a hill.

Snowpiercer starts with the concerns about global warming, and governments declare that they need to deal with this problem closely. Meanwhile, scientists launch CW7 an artificial cooler into the atmosphere to bring temperatures normal degrees.

Protests from environmental groups and a number of developing countries continue. It had been claimed The CW7 is the answer to global warming. And we are witnesses. Leaders who argue that global warming can no longer be ignored. Today, 79 countries will begin dispersing CW7 in the upper layers of the atmosphere. And surprisingly bring down the average global temperature to the finest levels. It is just a day away that according to scientists the artificial cooling substance CW7 will succeed in bringing average global temperature down to manageable level. As a revolutionary solution to mankind's warming of the planet. (Bong, 2013, 00:01:49)

This attempt is protested by environmental groups; however, the political powers give priority to defeat natural problems from human perspective. While the ideas suggested by environmental groups ignored, science and technology have been attached great importance. For a short period, people are convinced that CW7 leads to a revolution to control the temperature. In this part, it is apparent that the initial problem related to this disaster is anthropocentric ideology which is dominant on earth. Seeing human being as the master of nature gives them an opportunity to manipulate it and release dangerous chemicals into the atmosphere to establish control over it. However, it is important to know that human being is merely a component of nature, so when it is destroyed, it will have outcomes on human generation (Campbel, 1996). When the embeddedness of human within nature is ignored, natural disasters which are designed by human become inevitable as represented in the movie. Not surprisingly, after a while, they experience the apocalyptic outcomes of political and scientific decisions, as in the following lines:

Soon after dispersing CW7, the world froze all life became extinct. The precious few who boarded the rattling ark are humanity's last survivors. (Bong, 2013, 00:03:17)

The dystopia is declared by the quotation above, and only a group of people manage to survive by the help of “the rattling ark”. At this point, Garrard mentions that the apocalypse is always an ongoing matter for religion (2012). Not surprisingly, the invented train to survive from the disaster is resembled to the Noah’s ark in its function to gather people for the continuity of humankind. However, as opposed to the Noah’s ark, this train is designed only to save people and some kinds of animals for human’s consumption. It appears that even though they suffer from a catastrophe as a consequence of human greed, they are not aware of the real position of human in nature because they still try to have a control over it. Non-human is only regarded as a need for human use and survival. Moreover, the train as a vehicle can be associated with the locomotive in “The Machine in the Garden” by Leo Marx. In this article, a locomotive in the countryside is mentioned because it disturbs the nature with its aggressive style and annoying sound. It is associated with the upcoming technology and its effects on nature (Marx, 2000). Similarly, *Snowpiercer* works in the same direction. On one hand, it is seen as the saviour for humanity; on the other hand, the train is a product of technology which brings along the apocalypse. Depending on the anthropocentric ideology, it is invented to defeat nature and to authenticate the mastery of humanity over it because nature is figured as a simple unity to be managed while human mind is seen as a more complex entity (Love, 1996).

Moreover, Plumwood states that the inequality in social classes, ethnic groups, and hierarchy leads to ecological problems since every community protects their own interest ignoring ecological problems (2002). Most importantly, the upper class in a society causes the most problematic environmental issues because the privilege given to this group leads remoteness and inequality. Instead of dealing with the environmental problems, they keep their distance and buy new places (Plumwood, 2002). In a safe distance, they make decisions about the rest of the world including nature and people. As similar to the case in the train, while rich people have the power to control the rest of the world in their glorious compartments, people in the tail part watch for an opportunity to rebel and take the control as can be seen in the following quote:

Curtis: We control the engine, we control the world. Without that, we have nothing. All past revolutions have failed because they couldn't take the engine. (Bong, 2013, 00:10:52)

Curtis, the lead of the rebel, realizes that the power is associated with the engine. In other words, powers managing technology and science control the world and humanity, and to defeat the governing powers, they plan to take their place. In this dystopia, nature is obviously diminished as an enemy because it is seen as the cause of the apocalypse they suffer from, and it is to be taken under control by technology to survive. In ecocritical perspective, technology is regarded as an open unit to comment on. In this respect, White draws attention to the origin of the aggressive attitude of technology. He proposes that it is closely related with the attributed values to the mankind by Christianity and adds that the anthropocentric qualities adhered to technology and science will not work to defeat the ecological crisis, therefore (1996). Fromm also analyses the relation between nature and technology in a striking manner because he suggests that technology produced by human mind gives opportunity to human to figure themselves as strong as the gods, so nature is to be under their control (1996). Therefore, this illusion causes human being to be alienated from nature and ignore their roots in creation. The god-like figure adapted by technology is a common figure represented on board in the movie:

Mason: In the beginning, order was prescribed by your ticket. First bus, economy, and freeloaders like you. Eternal order is prescribed by the Sacred Engine. All things flow from the Sacred Engine. All things in their place. All passengers in their section. All water flowing, all heat rise pays homage to the Sacred Engine. (Bong, 2013, 00:18:06)

M.: The engine is sacred. And Wilford is divine. (Bong, 2013, 00:57:37)

In the same perspective, the sacred power of technology is pronounced by Minister Mason who is the second person in command. After a rebellious attempt, she gives punishment to the people in the tail, and she makes an announcement about how sacred their position in the world. She never loses her fixed idea about the divine power attributed to Wilford and pronounces it repeatedly. As it is stated before, the power attained by technology creates an illusion for people. As Mason accepts, Wilford is acknowledged as the god, and the engine is his world to order. The whole ecosystem serves through the used technology, and it is taken as superior to nature. In spite of the frozen world outside, the system created on board gives them power and makes them feel satisfied with their mastery over nature and natural disasters. As McGrath suggests, at the onset of the modernism, humanity gets the idea to control and dominate, and when they have the chance for an autonomous understanding of creation, their ideology highlights that “all can be mastered and controlled” including nature and traditions (2002, p. 78). Releasing from religious boundaries gives them an opportunity to create their own mechanisms and structures.

It is important to note that even though technology is considered as the super power, taking an advantage of nature is seen crucial by the rebels. The perpetual and unique system designed on train is attempted to be controlled by water. The following lines exhibit their hope with the power of nature:

Gilliam: The water supply section? (...)

Gilliam: It's one of the most crucial sections in the train.

Curtis: If we take it, we'll have the upperhand?

Gilliam: We don't even have to go to the very front. We control the water. We control the negotiation. (Bong, 2013, 00:38:55)

Gilliam, the oldest and wisest among the rebels, makes the suggestion to use water as leverage to take the control of the train. It appears that this idea is produced by Gilliam on purpose because he probably has a much wider experience to live on the world and knowledge to feel the superiority of nature over technology. In other words, he has a chance to create a new understanding about the power of nature to heal and to hope. As Clark points, upon attributions onto the wild nature, it is eminent to consider it as a power of recovery and a source to find the actual identities encapsulating the spiritual, political, and national realms (2011). Therefore, it is clear that the disaster caused by technology can only be cured by the healing power of nature, and it gives opportunities to create a new world to live on.

It is also obvious that on a technologically created mechanism, they need nature to survive. However, it should be controlled precisely to maintain sustainability and to keep the balance of nature, as the lines below exhibit:

Mason: This aquarium is closed ecological system. And the number of individual units must be very closely, precisely controlled. In order to maintain the proper sustainable balance. (Bong, 2013, 01:05:37)

Mason is taken hostage by rebels to go towards the engine. Meanwhile, they stop by in the aquarium section which offers sushi twice a year. The reason behind having it twice a year is explained as to maintain sustainability and to control nature closely. It is clear that nature is seen as a tool for human being, and it is basically caged under the control of technology as Fromm mentions (1996). It is also related to the case suggested by Plumwood because the privileged class creates their own ecology

under their control, and they animate divine powers in their remote areas (2002). Moreover, the anthropocentric understanding on nature gives them rights to order the nature for their own existence.

Along with the discovery of the created ecology, it is also significant to realize the human struggles to survive from the disaster. Towards the end of the rebel, Curtis reaches the gate of the engine and loses his temper because of the loss of his fellows, and he reveals what they have experienced during their journey on board:

Curtis: When we boarded? It was chaos. We didn't freeze to death. But we didn't have time to be thankful. Wilford's soldiers came and they took everything. It was thousand people in iron box... no food, no water. After a month, we ate the weak. You know what I hate about myself? I know what people taste like. I know that babies taste best. (Bong, 2013, 01:28:37)

People in tail are left with no food or water. In order to survive, they start to eat each other. In ecological perspective, this quotation signals the human's position in food cycle. In anthropocentric view, human does not belong to the chain, and non-human is created to supply and serve as food. However, this issue creates a hot- debate by those who support that human should be placed in food chain like animals, and every organism has equal right to live and to save themselves from being the other's food. Plumwood also mentions that people supporting animal rights propose that eating animal flesh can be seen as equal to cannibalism, and the egalitarian structure on nature requires putting humankind into the food cycle (2000). Similarly, the case on Snowpiercer can be taken as a good instance to think about the human's definition in food cycle. When they are suffered from famine, they have to practice cannibalism to survive. Curtis feels great regret about what they have done; however, it is salient that human nature reveals itself in the case of a calamity.

The inequality created by the privileged class in the society leads corruption not only on nature but also on humankind. As in the case of the people in the tail, they attempt to take revenge ignoring nature with the hatred towards the upper class. In other words, instead of healing and valuing the nature to get rid of the disaster, they focus on getting the power to control the others. Upon telling his story, Curtis wants Namgoong Minsoo to open the door to the engine. However, he has some other plans:

Namgoong Minsoo: I want to open a door. But not this one. That one. The one that leads to the outside. (Bong, 2013, 01:33:34)

N. M.: But maybe we can survive. Every new year, I check something. We see the wreckage of a plane... under the snow. For ten years the tail can barely seen. But now I can see the fuselage and wings. There is less and less snow and ice. It melts. (Bong, 2013, 01:34:19)

Namgoong Minsoo is the former security expert who has designed the door system on train, but then he is jailed in the drawers which are designed as the prison of the train. At the very beginning of the revolt, he is released by Curtis to open the doors to the engine. Finally, when they reach there, instead of opening the door to the engine to take the control, he suggests focussing on nature mentioning the healing weather condition on the world. It appears that he is aware of the fact that being on the train or managing it is not the solution to survive, but instead he observes nature and tries to find a way to be there again. Even though the overall plot of the movie is based on apocalyptic details, they have signals about hope towards the end. In ecocritical perspective, it can be considered as the intended message conveyed by the possibility of the apocalypse. In spite of the deterioration of the ecosystem by human interruption, it is possible to save the world from a possible ending on condition that the necessary precautions are taken. As Garrard underlines, if the signals are read properly about the environmental apocalypse, it is possible to refrain from the destructive

consequences (2012). Therefore, the movie provides a base to create a new cognition towards environmental issues.

However, before going onto the survival scenarios, the movie exhibits the devastating facts designed by the political powers and wealthy groups of the society about the continuity of humanity on the world. As it is clearly stated in the following quotes by Wilford:

Wilford: Curtis, everyone has their preordained position. And everyone is in their place except you. (Bong, 2013, 01:38:14)

Wilford: The fact is that we are all stuck inside this blasted train. We are prisoners in this hunk of metal. (Bong, 2013, 01:38:35)

Upon Curtis's reaching to the engine, he meets Wilford and witnesses that the people on the train are considered as a part of a big plan. Moreover, Wilford, who is thought as the divine power of the train, describes their positions and their livings as a fair situation and as a form of destiny. This scene is also parallel with Plumwoods's ideas about the consequences of the privileged classes' desires about the environment. They create their own borders and hinder the others to pass through them, and unfortunately, they cause environmental deterioration (Plumwood, 2002). Not surprisingly, it represents the general attitude acknowledged by the economic and political powers in today's world as similar to the one on the train:

Wilford: And this train is a closed ecosystem. We must always strive for balance. Air, water, food supply, population. It must all be kept in balance. For optimum balance, however there'll have been time when more...radical solutions were required. When the population needed to be reduced, rather drastically. We don't have time for true natural selection. We would all be hideously over crowded and starved waiting for that. The next best solution is to have individual units kill off other individual units. (Bong, 2013, 01:38:44)

Furthermore, the quotation above shows the human greed to control not only the nature but also the people oppressed in the society. It is a cruel fact that the upper-class manipulates every organism on the world for their own benefits, and even they create a convenient setting for natural selection to provide a progress in their lives. As it is repeated frequently, the humankind seeing themselves as the manager of the universe with the power of technology builds their own system on the train:

Wilford: we need to maintain the proper balance of anxiety and fear... chaos and horror in order to keep life going. If we don't have that, we need to invent it. (Bong, 2013, 01:44:20)

Wilford: The train is the world. We the humanity. And now you have the sacred responsibility to lead all humanity. (Bong, 2013, 01:48:33)

The dominant ideology based on the anthropocentrism leads the humanity to fight with nature for their survival. However, as it is stated before, the fight with nature also includes the oppressed groups, and they are regarded as a tool for the welfare of the upper class. Even in the mechanism of the train, they are exploited mercilessly, as Wilford confesses:

Wilford: Young children under 5. The engine lasts forever but not to all of it's parts. That piece of equipment went extinct recently. We needed a replacement. Thank goodness the tail section manufactured us a steady supplies of kids. So we can keep going manually. (Bong, 2013, 01:51:08)

Even though the engine has a perpetual structure, they need to change the mechanic parts in time. When the pieces are extinct, they start to use the children under five years old from the tail instead of the eroded equipment. The illusion resulted by the power of technology causes “spiritual death” for human beings (Fromm, 1996, p. 32). The desire and power to use technology let the scientists, politicians, and the upper class of the society rein the world and the others including oppressed groups as tool for their own benefits. It is obvious that their financial power encourages them to dominate the others in the society and nature.

As it is stated before, in spite of the apocalyptic details and deterioration of nature represented throughout the movie, the final scene gives a sense of hope about the world and humanity. While Curtis has a discussion with Wilford, he feels disappointment upon the truths, and he faces with the idea that controlling the engine is not the solution for survival. Meanwhile, Namgoong Minsoo and his daughter cause an accident, and the train derails. It can be considered as a kind of suicidal act, but in deeper sense, it can be considered as an attempt to reach nature by escaping from the technology in which they have been trapped for years. After the accident, the only survivors are the Namgoong Minsoo’s daughter and a 5-year-old boy working in the engine, and they realize that the temperature is getting normal for their living in the atmosphere. When they go out of the train, a polar bear is seen on the hill. It is obvious that it is the signal of revival and recovery of nature.

Consequently, the movie demonstrates the apocalyptic consequences of human interruption on nature. It is depicted through a dystopia and human struggles. In ecocritical perspective, it represents instances about the interaction between human nature, and how the privileged groups lead the end of the world with their anthropocentric ideologies.

CONCLUSION

The interaction between human and nature has always been hotly- debated topic, and it is delineated in different forms of art including science-fiction movies. Therefore, in this study, it is attempted to reveal the human and nature interaction in the movie *Snowpiercer* concerning the ecocritical perspective. Through the depictions represented in the movie, a dominant apocalyptic vision reflects the main theme, and the consequences of human interruption on nature are witnessed. Generally, it is observed that the deterioration of the world and nature is caused by scientific and technological revolutions supported by political and financial powers in the world. Moreover, the study puts an emphasis on the fact that humankind is a part of nature instead of its master, and any attempt to get mastery over it will possibly cause a catastrophe for the humanity. It is also important to note that taking these kinds of movies as a warning to get rid of the possible apocalypse will be reasonable to anticipate the outcomes of the human interruptions on nature and to find out useful solutions to eliminate the negative effects caused by humanity.

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**INVESTIGATION OF GLOBAL CLIMATE CHANGE EFFECTS AT MERSIN
(TURKEY) SCALE**

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ABSTRACT

The effects of global warming are increasing worldwide. Climate change poses a serious threat, especially for places located in the Mediterranean basin. In this respect, Mersin, located in the Mediterranean basin in southern Turkey, was selected as the study area. The current and future possible climate features of the study area were determined, and then climate change was analyzed. For this purpose, HadGEM3-GC31-LL shared socio-economic pathways SSP2-4.5 and SSP5-8.5 scenarios from global climate models were used. The models are produced for the 2021-2100 projection period, and this period is divided into 20-year periods as (2021-2040), (2041-2060), (2061-2080), and (2081-2100). The data obtained were compared, and it was expected that by the end of the 21st century, warming would be roughly 3.2°C under the SSP2-4.5 scenario and 4.4°C under the SSP5-8.5. On the other hand, precipitation levels fell estimated by 6.5% and 8.5%, respectively. The findings show that the study area is highly vulnerable to climate change in the future. that the study area is highly vulnerable to climate change in the future.

Keywords: Climate Change, Drought, SSP2-4.5, SSP5-8.5.

INTRODUCTION

The harmful impacts of global climate change are becoming more widespread and directly endanger the lives of living beings. The earth has warmed by 1.1°C, and 1.5°C is the acceptable climatic limit (Carbon Brief, 2024a; Robinson & Shine, 2018). In other words, by 2100, the global average surface

temperature will have risen no more than 1.5°C above pre-industrial levels (1850-1900) (BBC, 2024; Carbon Brief, 2024b) However, developed global climate models (GCMs) show that global warming is on an increasing trend (Ai et al., 2024; Nazarenko et al., 2022). As a result, climate change's adverse effects on the world will worsen with time. Therefore, it is evident that the negative effects of climate change on the world will gradually increase. Natural disasters such as floods, floods, fires and droughts will become more frequent and all living things, especially humans, will be adversely affected. Many regions are already impacted.

A flood risk analysis of the Tajan basin in the context of climate change was conducted by Avand et al. (2021). To achieve this, representative concentration paths (RCP 2.6 and RCP 8.5) were employed. The impact of climate change on the USA example was analyzed by Mitchell et al. (2014). Another study conducted by Huang et al. (2024) examined the potential effects of climate change on snow and groundwater drought in Canada. Kriticos et al. (2003) stated that the potential of the invasive species *Acacia nilotica* in Australia due to global climate change will significantly increase in the region.

The principal adverse impact of global climate change in the Mediterranean basin is drought (Garrido-Perez et al., 2024; Simsek, 2021 Stefanidis et al., 2023). Turkey, which experiences predominantly arid conditions during the summer months, is situated within the Mediterranean basin, rendering it susceptible to the adverse effects of drought (ÇŞİB, 2024a). It is therefore important to monitor the current climate characteristics of Turkey and to determine the potential effects of climate change. At this juncture, Mersin, which is extremely vulnerable to the effects of climate change with its climate characteristics and location, was selected as the study area and it was aimed to create climate scenarios to determine the possible effects of climate change. This study was undertaken due to the absence of a comprehensive and extensive investigation of Mersin.

STUDY AREA

The province of Mersin, which is in southern Turkey, serves as the study area (Figure 1). Mersin, which is in the Mediterranean basin, experiences dry summers and a sub-tropical Mediterranean climate (Stefanidis et al., 2023). Mersin is likely to be poorly impacted by global climate change, which is progressively affecting the entire planet. This climate zone, which it is under the influence of, has a semi-arid climate characteristic. Thus, it was decided to use it as the study area.

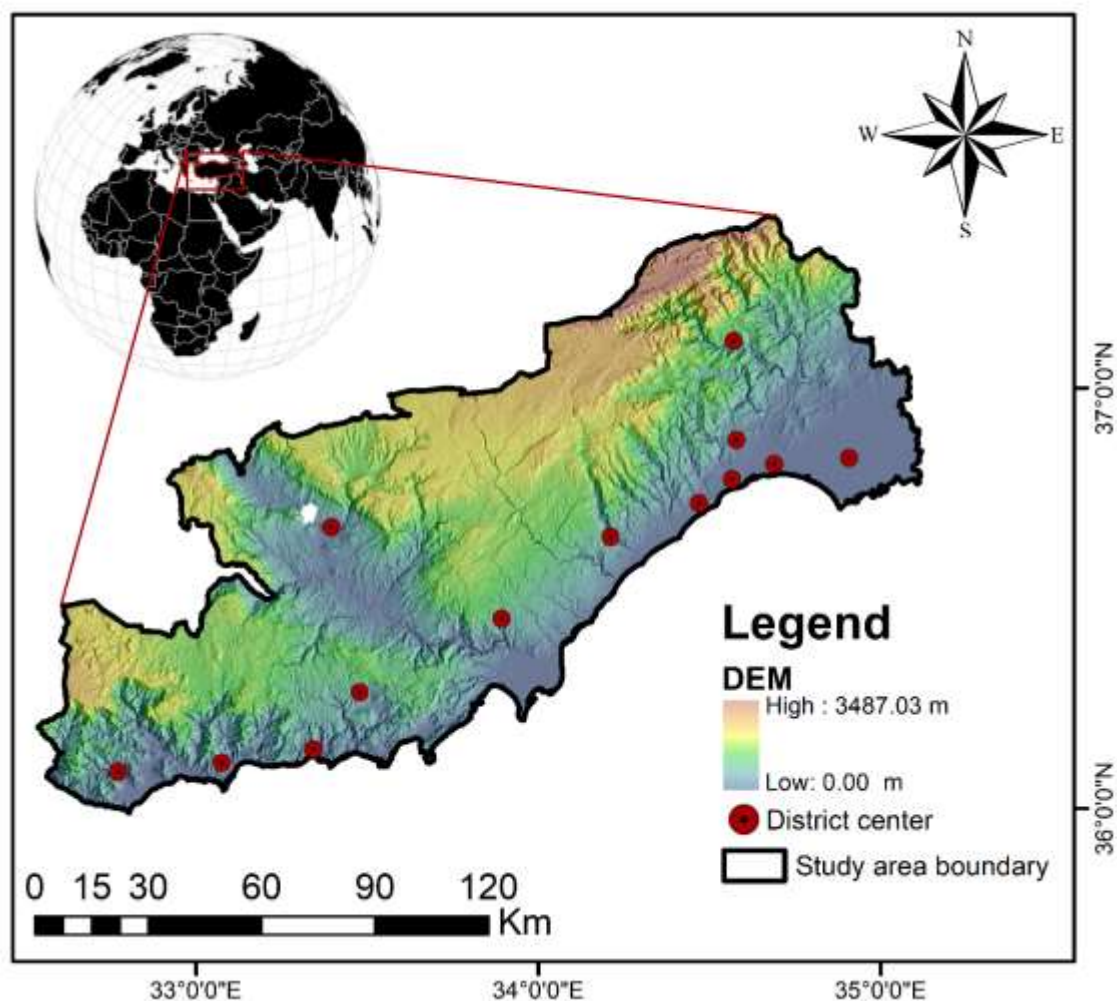


Figure 1. Study area

METHODOLOGY

This study aimed to determine the current and potential climate characteristics of the study area under the influence of climate change, and a three-stage method was applied for this purpose. Firstly, the current climate data of Mersin were obtained from WorldClim (WorldClim, 2024). Secondly, the current climate characteristics were determined. Finally, the climate change scenarios and their potential effects were determined (Figure 2). For the final target, HadGEM3-GC31-LL from the global climate models within the scope of Coupled Model Intercomparison Project Phase 6 (CMIP6) and the shared socio-economic pathways (SSP) SSP2-4.5 and SSP5-8.5 scenarios included in the IPCC 6th assessment report of the Intergovernmental Panel on Climate Change (PCC) were used. According to the climate (temperature) features of Turkey, the temperature value obtained from the HadGEM3-GC31-LL model was preferred because the models made by MGM were consistent with them (ÇŞİB, 2024a, ÇŞİB, 2024b). In addition, the major cause for selecting the SSP2-4.5 and SSP5-8.5 scenarios was that they were the most commonly used scenarios expressed in the IPCC 6th assessment report (TOB, 2024; WorldClim, 2024). SSP2-4.5 are scenarios that limit global warming to around 3°C by 2100, and SSP5-8.5 to almost 5°C.

The climate projection for Mersin was determined through the utilization of a climate model and the incorporation of defined scenarios. To this end, the period between 1971 and 2000 was taken as a reference point, and the monthly average temperature and total precipitation values produced by the climate model were calculated and compared with the meteorological observation data. Subsequently, models were constructed for the 2021-2100 projection period within the scope of the SSP2-4.5 and SSP5-8.5 scenarios. This period was then classified into four distinct time configurations: (2021-2040), (2041-2060), (2061-2080) and (2081-2100). The results of the climate models were then compared with the reference period (1971-2000) in order to analyze the changes (ÇŞİB, 2024b, WorldClim, 2024).

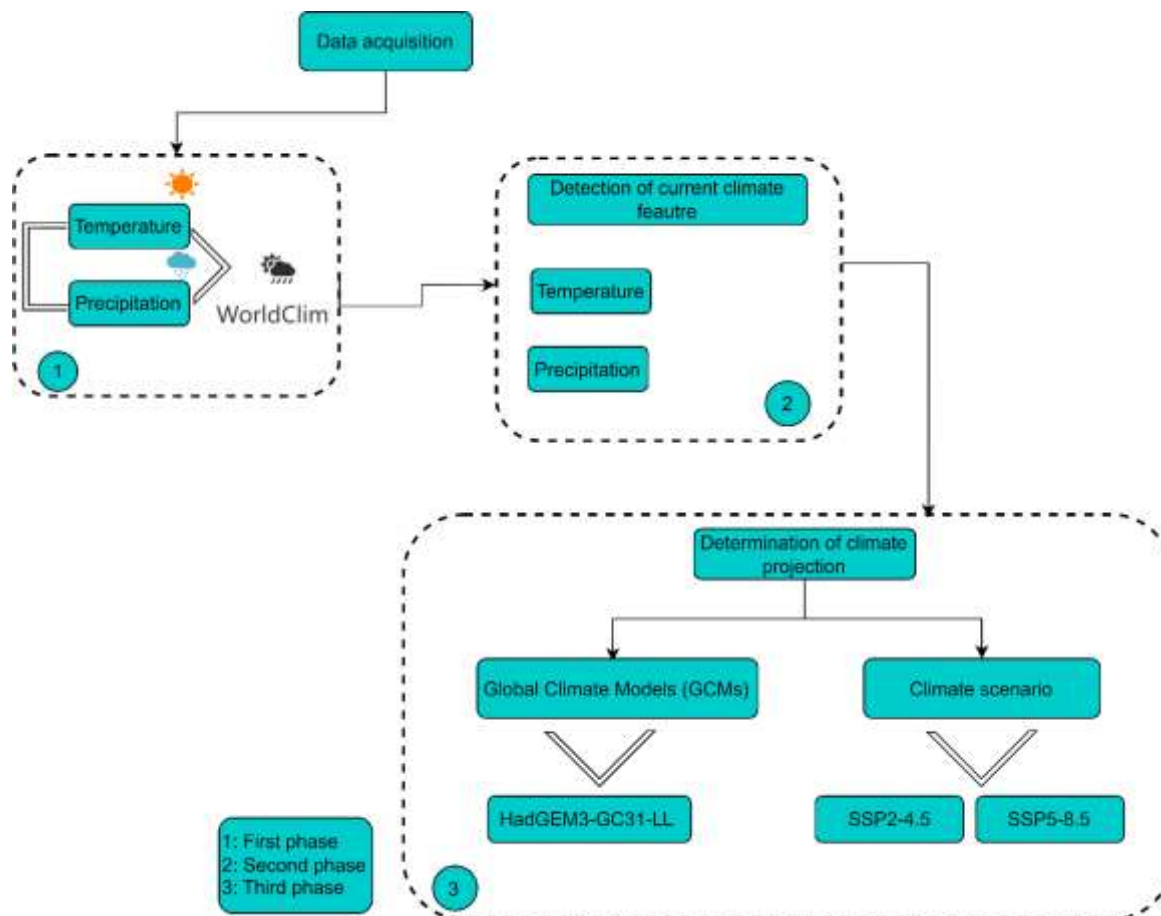


Figure 2. Flowchart of the study method

RESULTS

The current and potential future climate characteristics of the study area were identified. To this end, reference period temperature and precipitation maps were first produced (Figure 3).

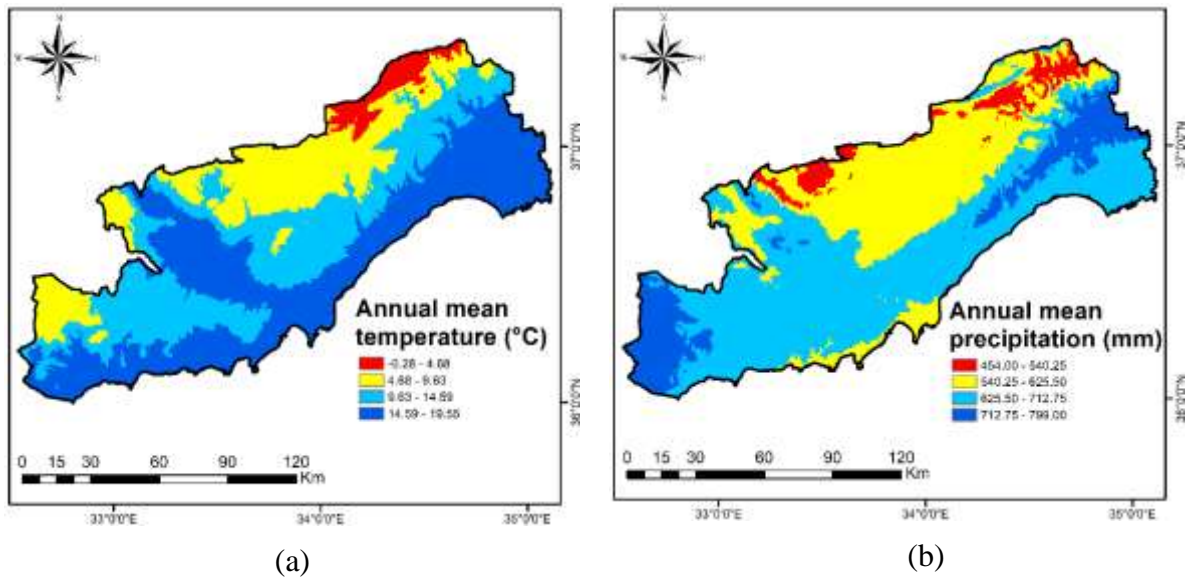


Figure 3. (a) Annual mean temperature, (b) Annual mean precipitation maps

Secondly, climate characteristics for the 21st century were determined using HadGEM3-GC31-LL GCM and SSP2-4.5 and SSP5-8.5 scenarios. The distribution of temperature and precipitation maps of the period were divided into 20-year periods (Figure 4-11).

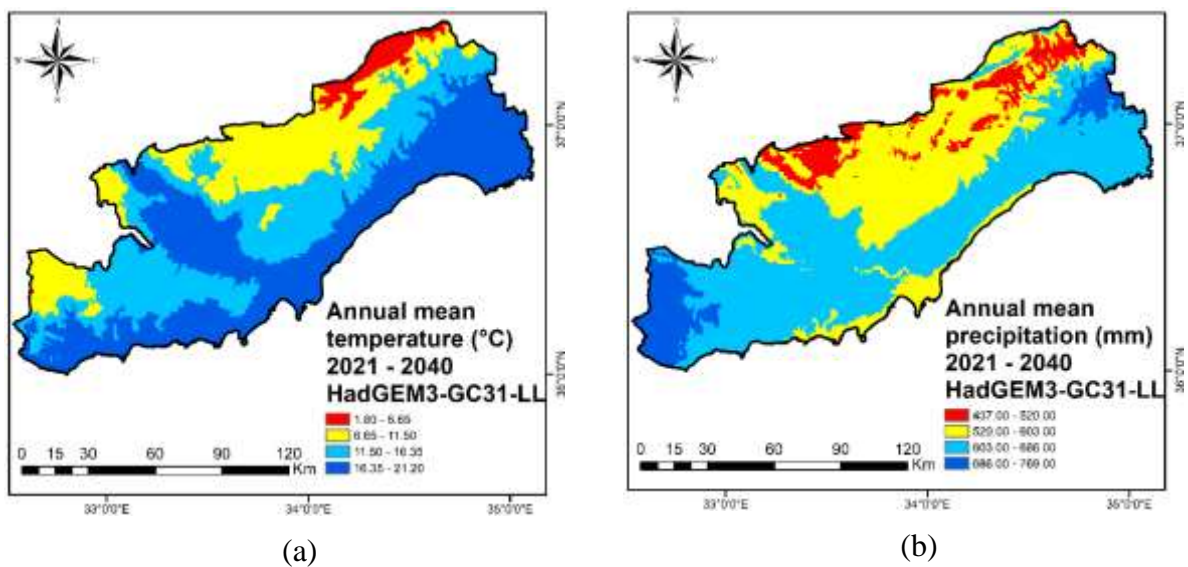


Figure 4. (a) Annual mean temperature map, (b) annual mean precipitation map produced using SSP2-4.5 scenario for the period (2021-2040)

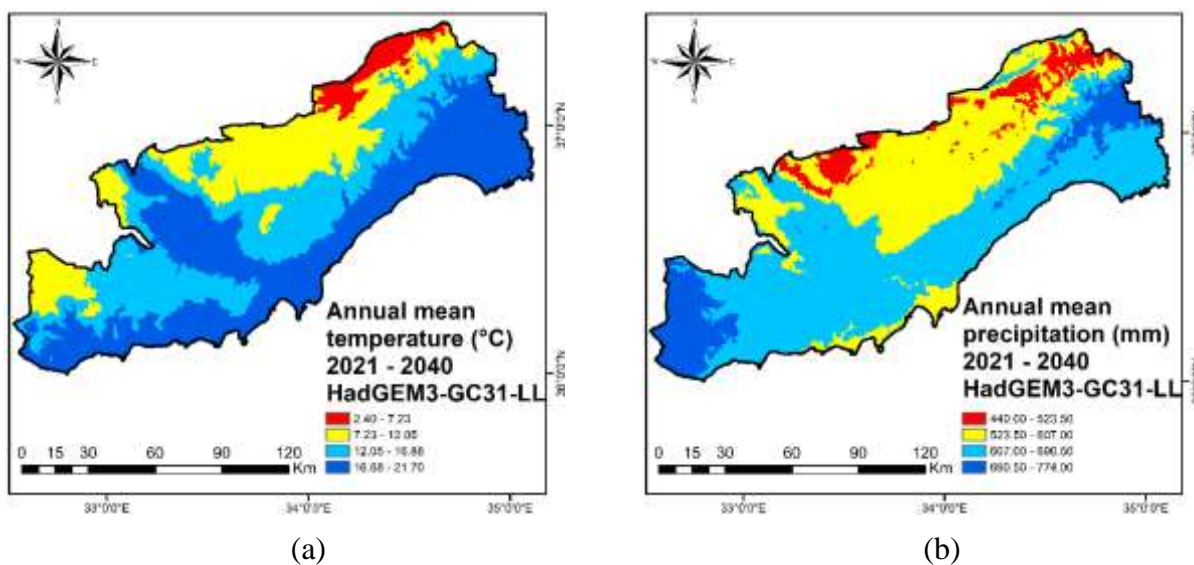


Figure 5. (a) Annual mean temperature map, (b) annual mean precipitation map produced using SSP5-8.5 scenario for the period (2021-2040)

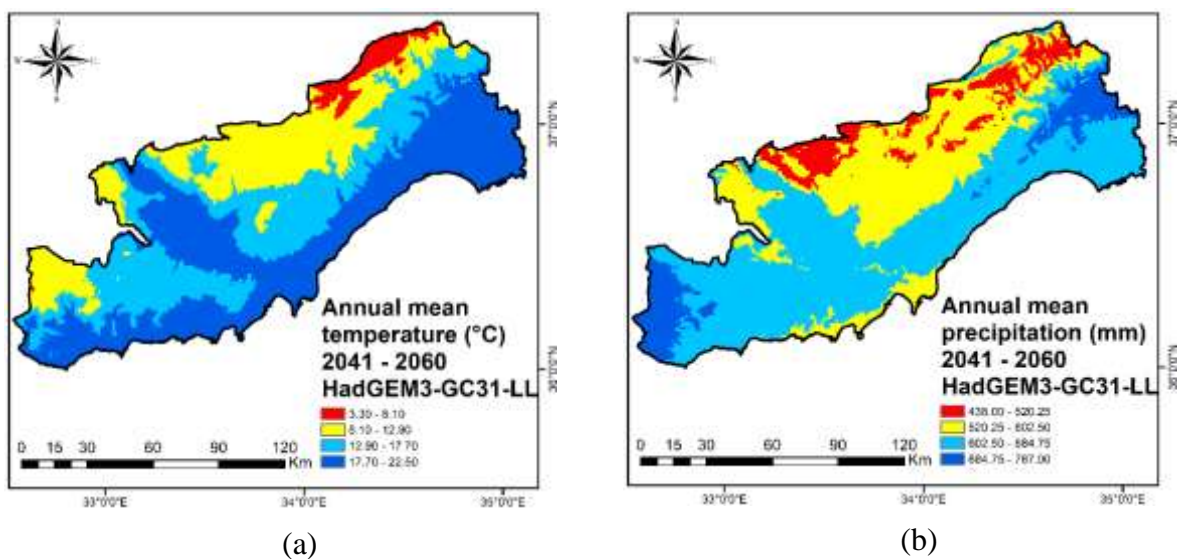


Figure 6. (a) Annual mean temperature map, (b) annual mean precipitation map produced using SSP2-4.5 scenario for the period (2041-2060)

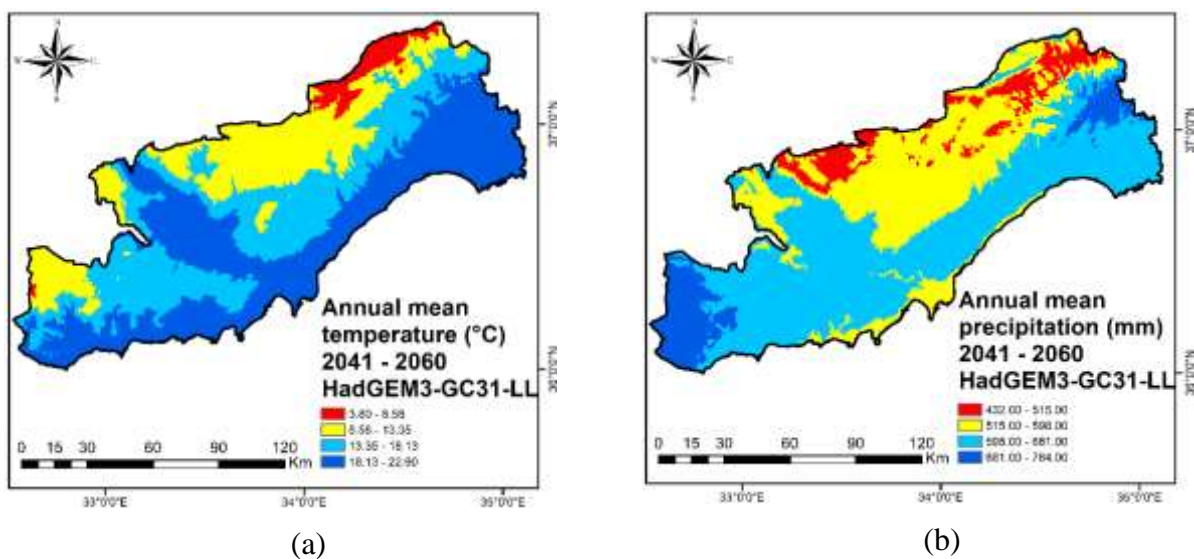


Figure 7. (a) Annual mean temperature map, (b) annual mean precipitation map produced using SSP5-8.5 scenario for the period (2041-2060)

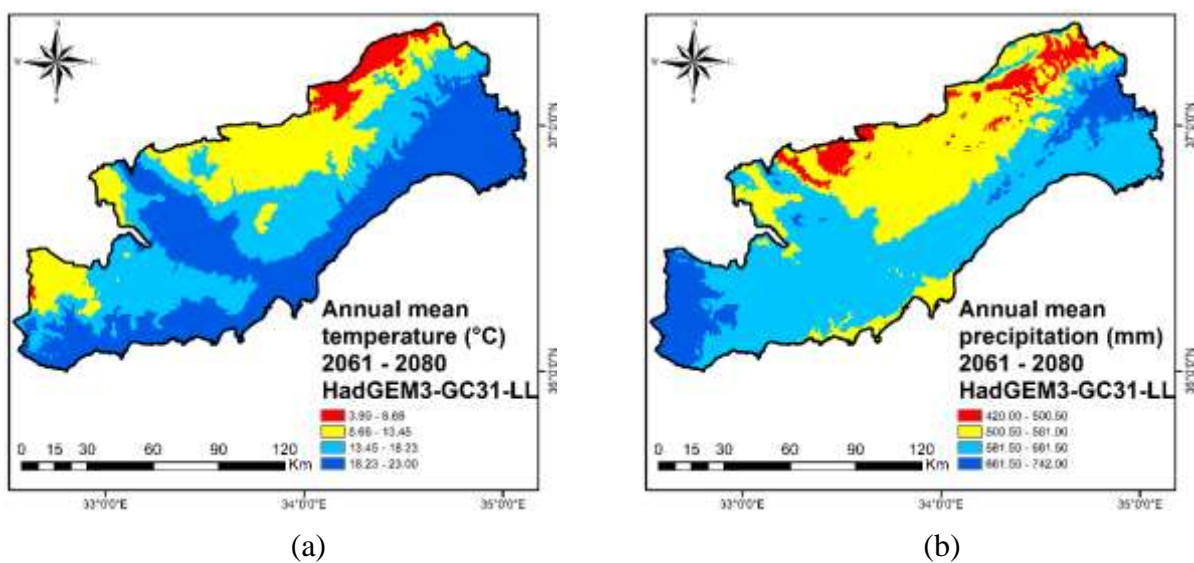


Figure 8. (a) Annual mean temperature map, (b) annual mean precipitation map produced using SSP2-4.5 scenario for the period (2061-2080)

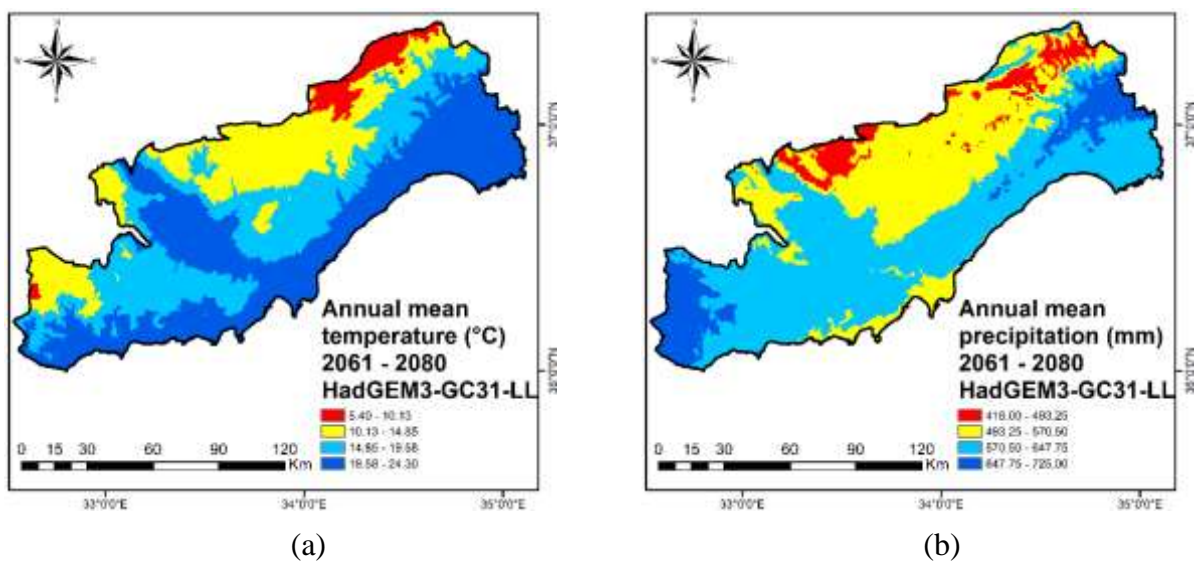


Figure 9. (a) Annual mean temperature map, (b) annual mean precipitation map produced using SSP5-8.5 scenario for the period (2061-2080)

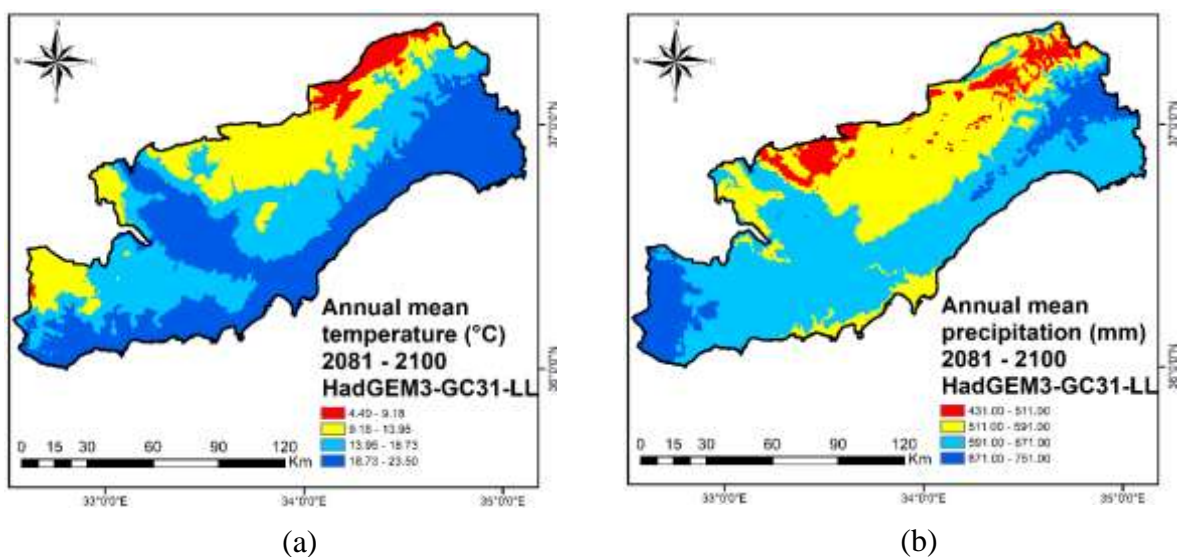


Figure 10. (a) Annual mean temperature map, (b) annual mean precipitation map produced using SSP2-4.5 scenario for the period (2081-2100)

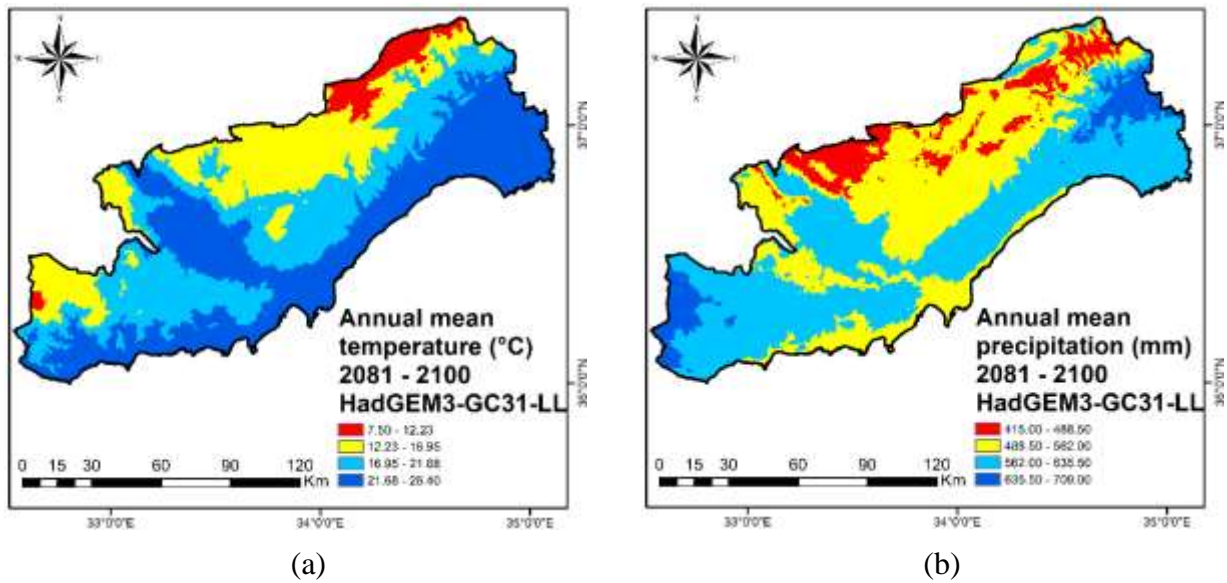
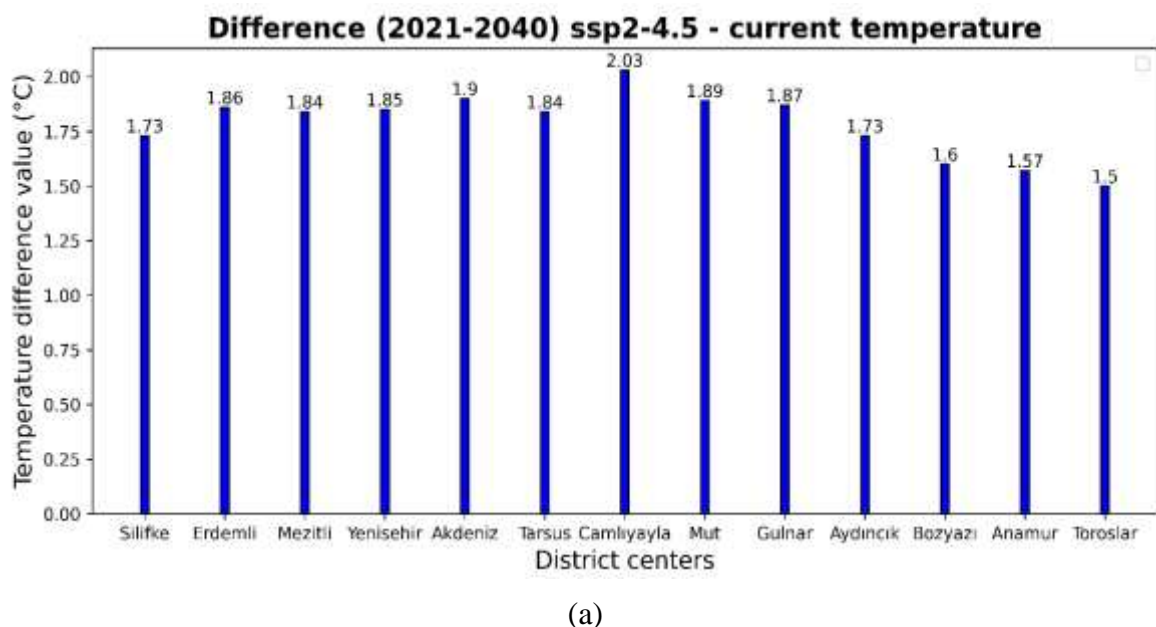
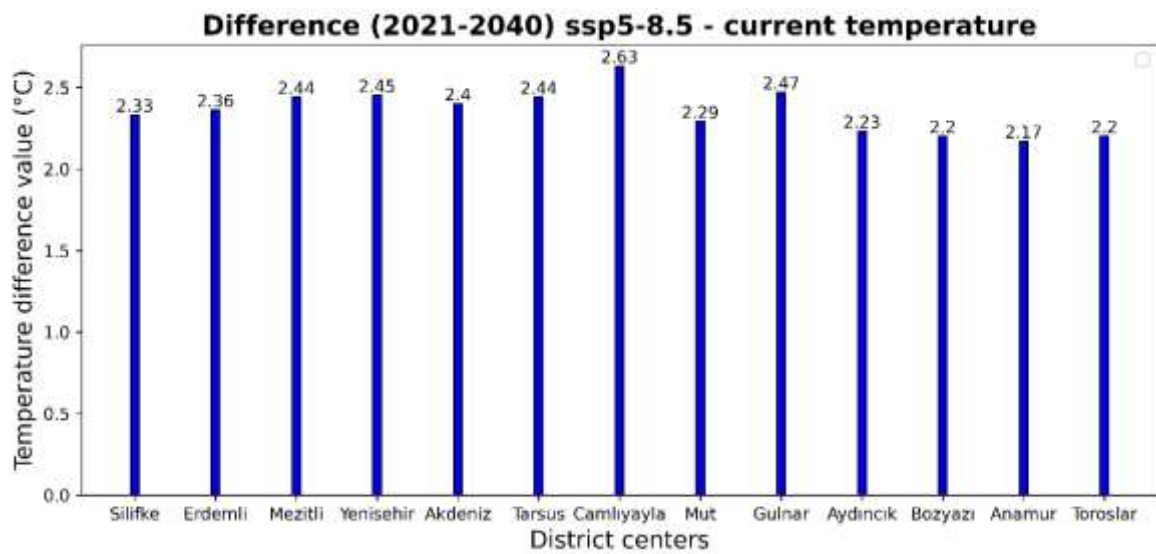


Figure 11. a) Annual mean temperature map, b) annual mean precipitation map produced using SSP5-8.5 scenario for the period (2081-2100)

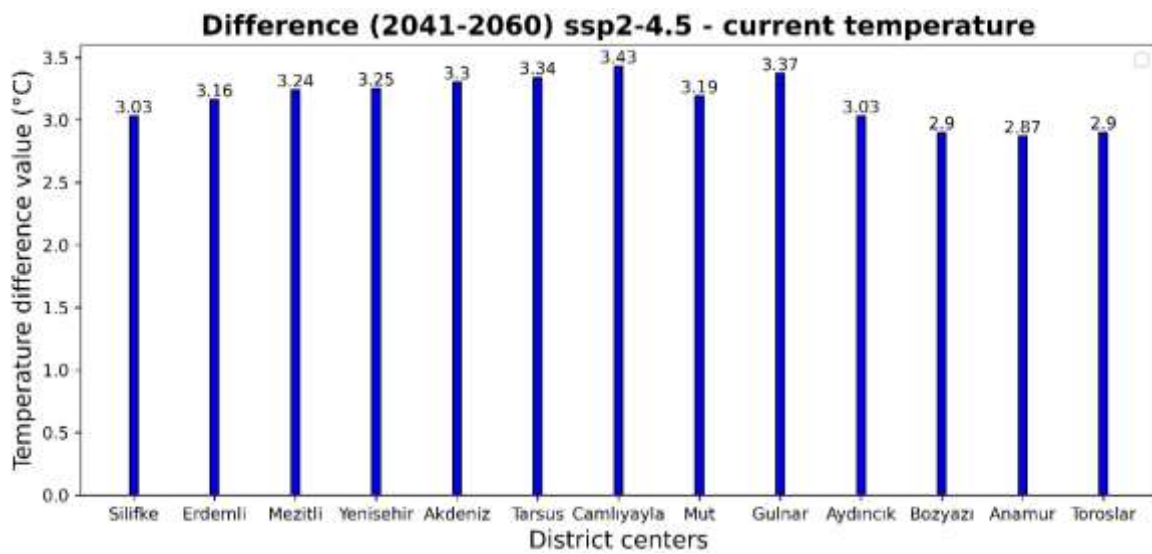
Finally, current and future climate characteristics were compared and differences were revealed. First, temperature changes (Figures 12-15) and then precipitation (Figures 16-19) were presented. For this purpose, climate (temperature and precipitation) data from a total of 13 district centers of Mersin were used. Current and possible future climate values were analyzed and graphs were created.



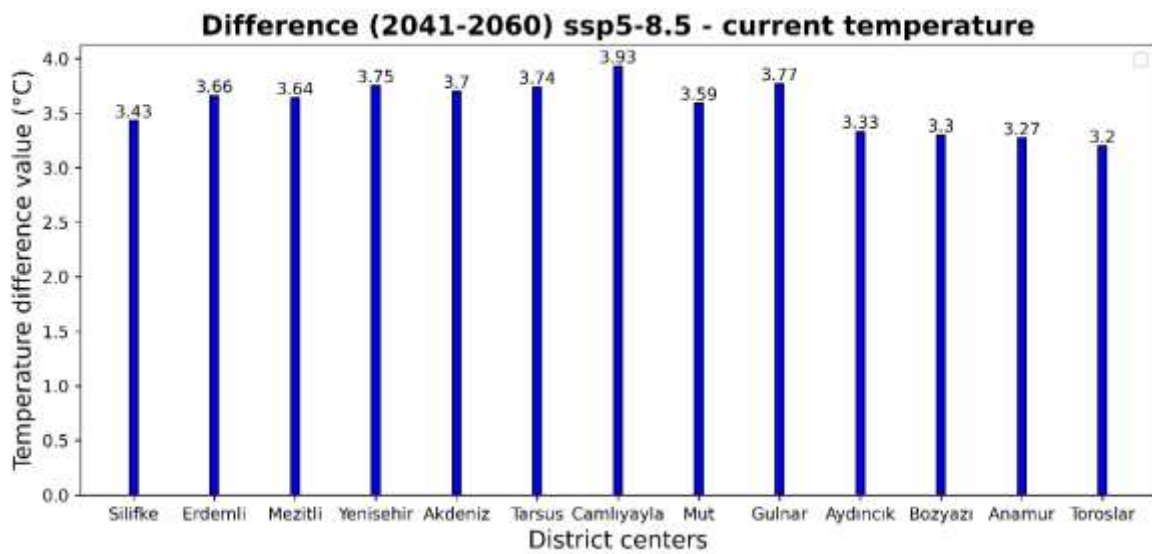


(b)

Figure 12. Differences between the data produced using the SSP2-4.5 and SSP5-8.5 scenarios for the period (2021-2040) and the current temperature data

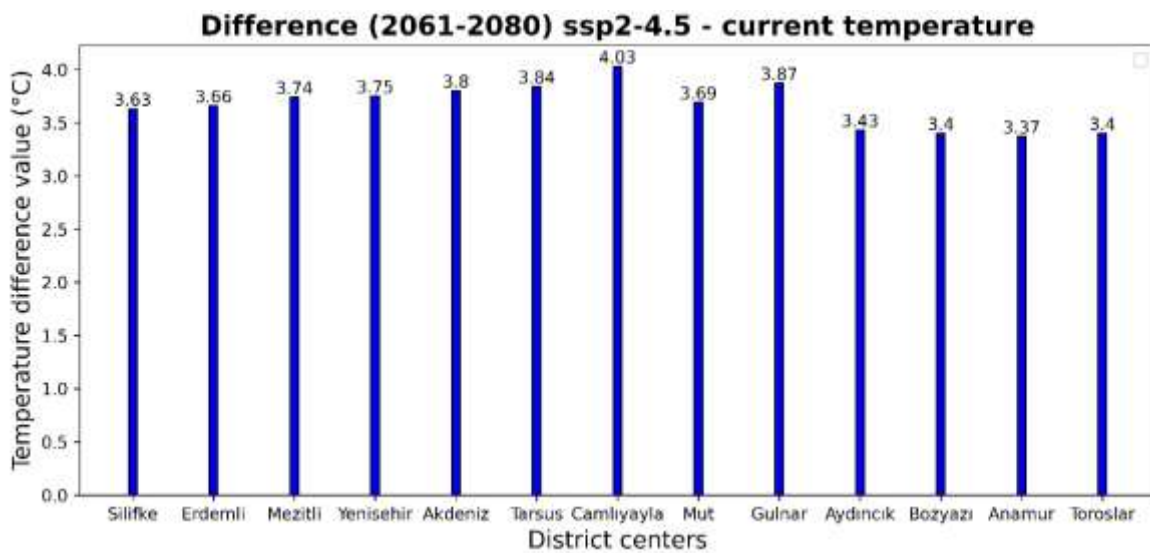


(a)

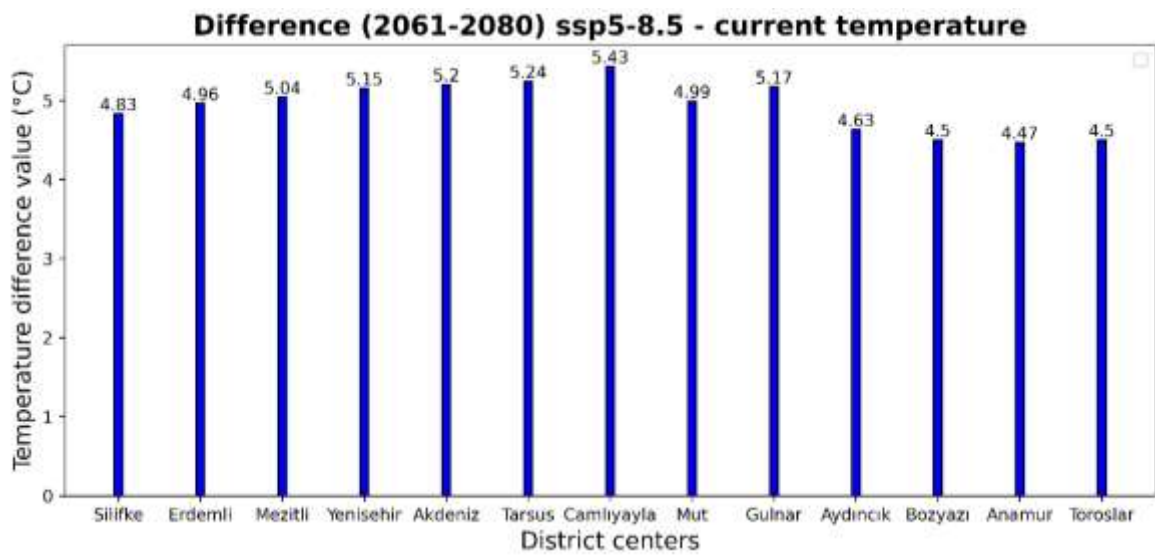


(b)

Figure 13. Differences between the data produced using the SSP2-4.5 and SSP5-8.5 scenarios for the period (2041-2060) and the current temperature data

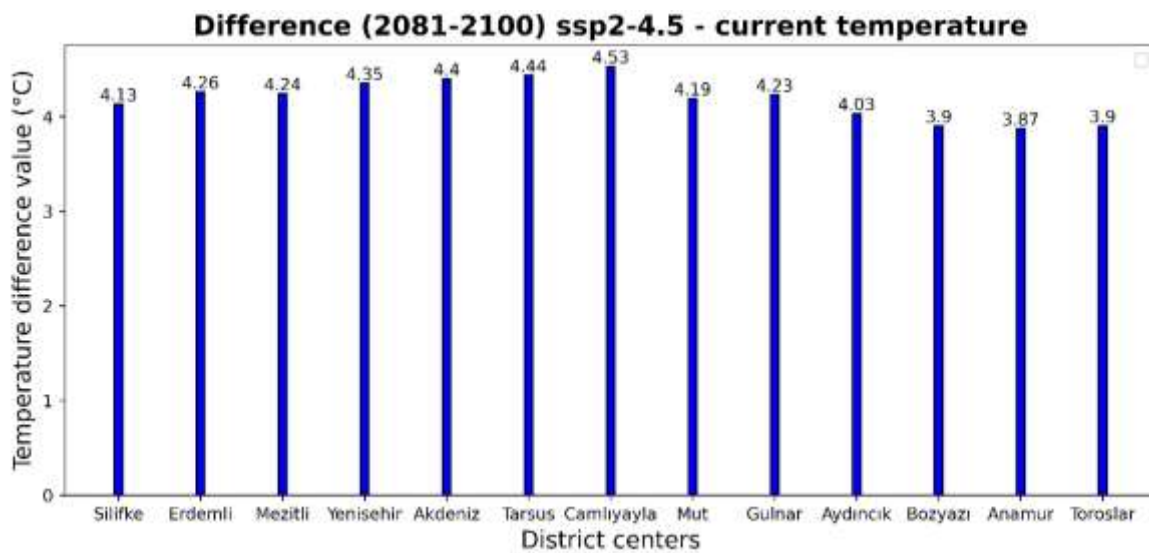


(a)

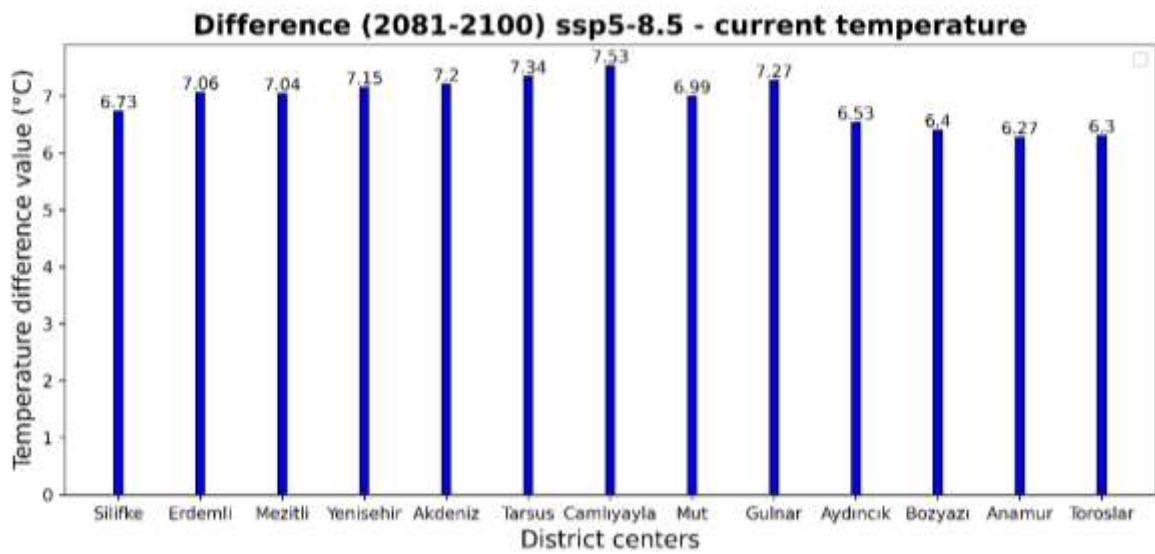


(b)

Figure 14. Differences between the data produced using the SSP2-4.5 and SSP5-8.5 scenarios for the period (2061-2080) and the current temperature data

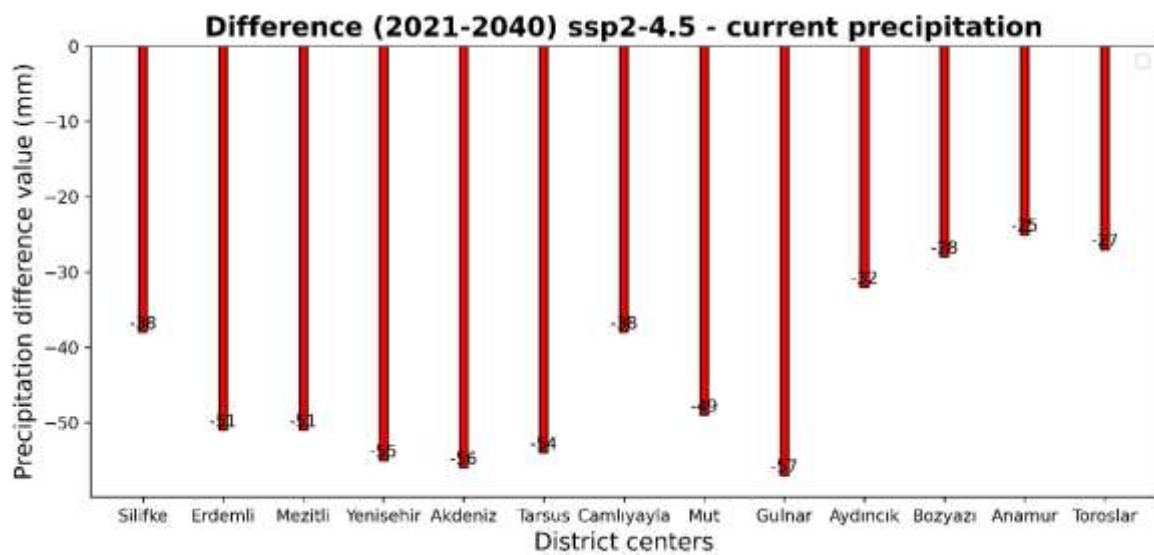


(a)

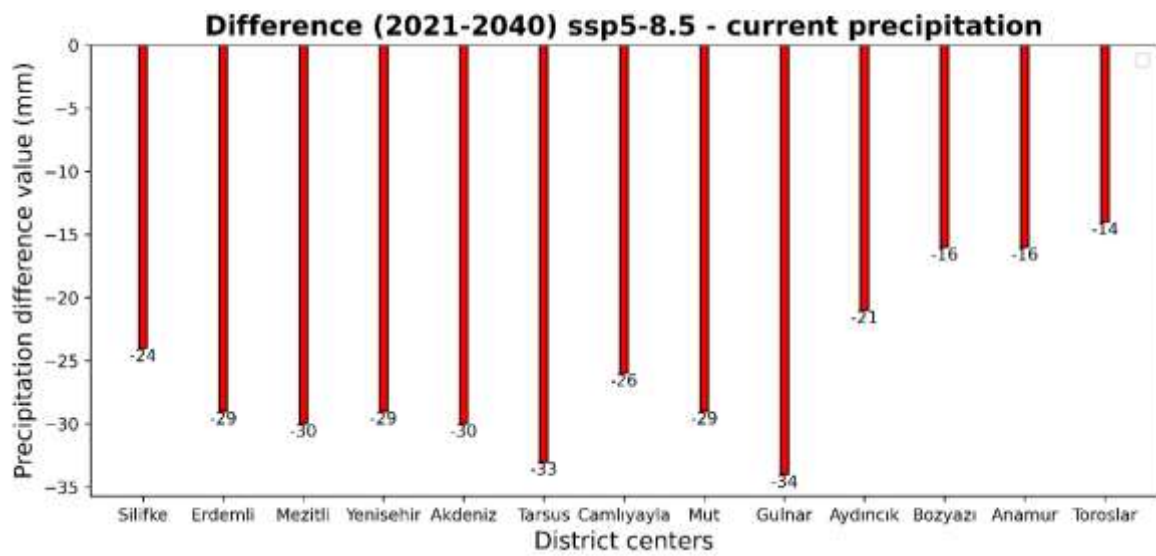


(b)

Figure 15. Differences between the data produced using the SSP2-4.5 and SSP5-8.5 scenarios for the period (2028-2100) and the current temperature data

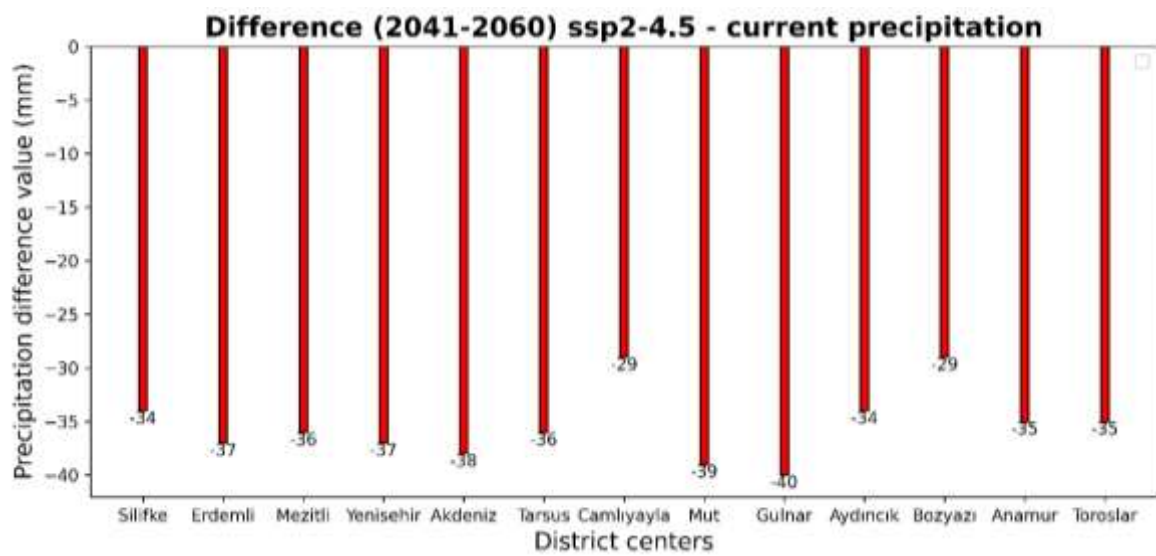


(a)

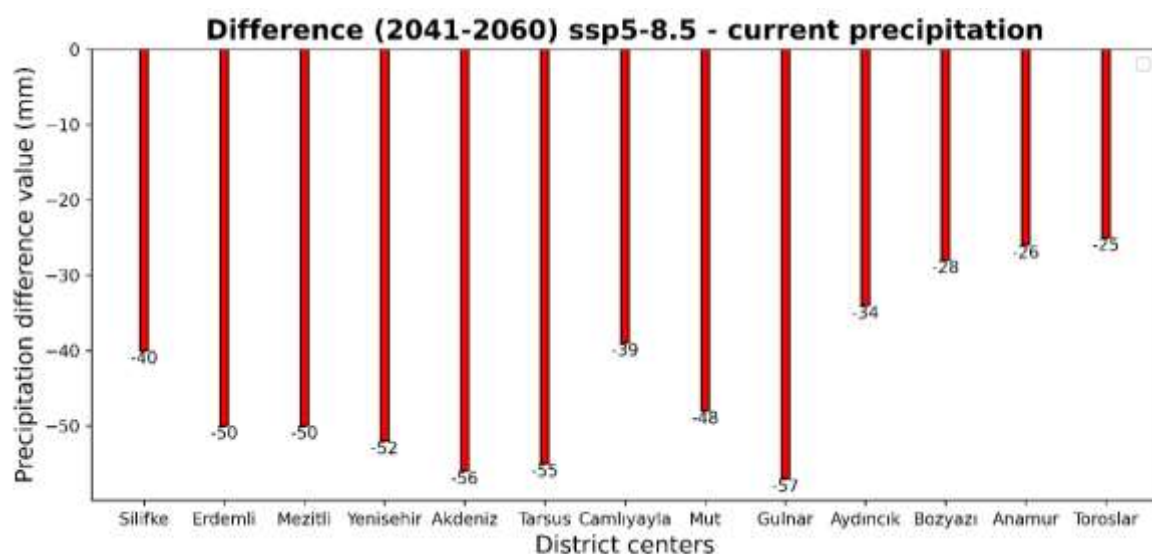


(b)

Figure 16. Differences between the data produced using the SSP2-4.5 and SSP5-8.5 scenarios for the period (2021-2040) and the current precipitation data

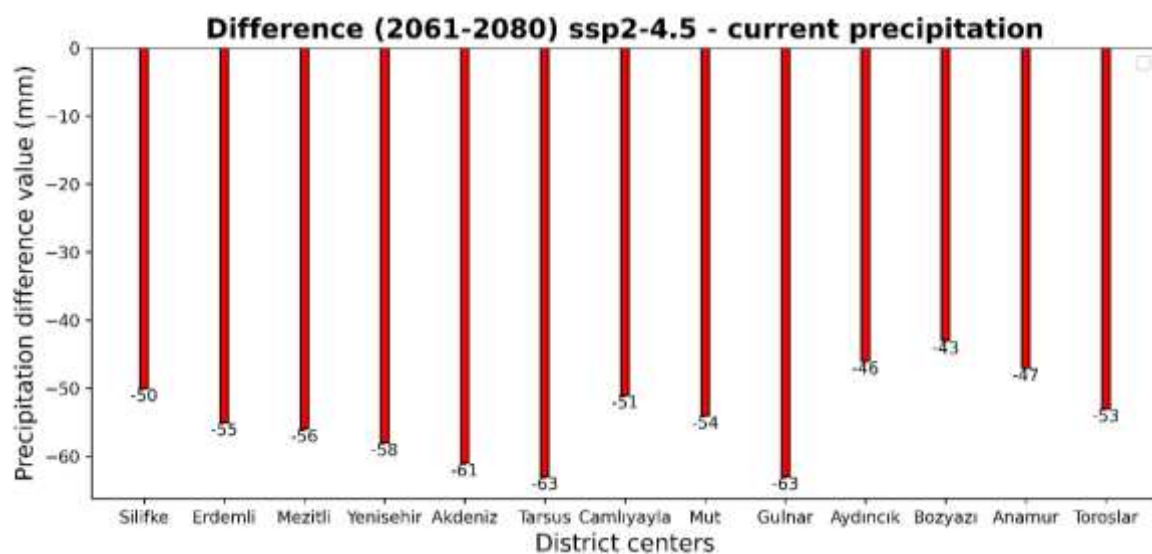


(a)

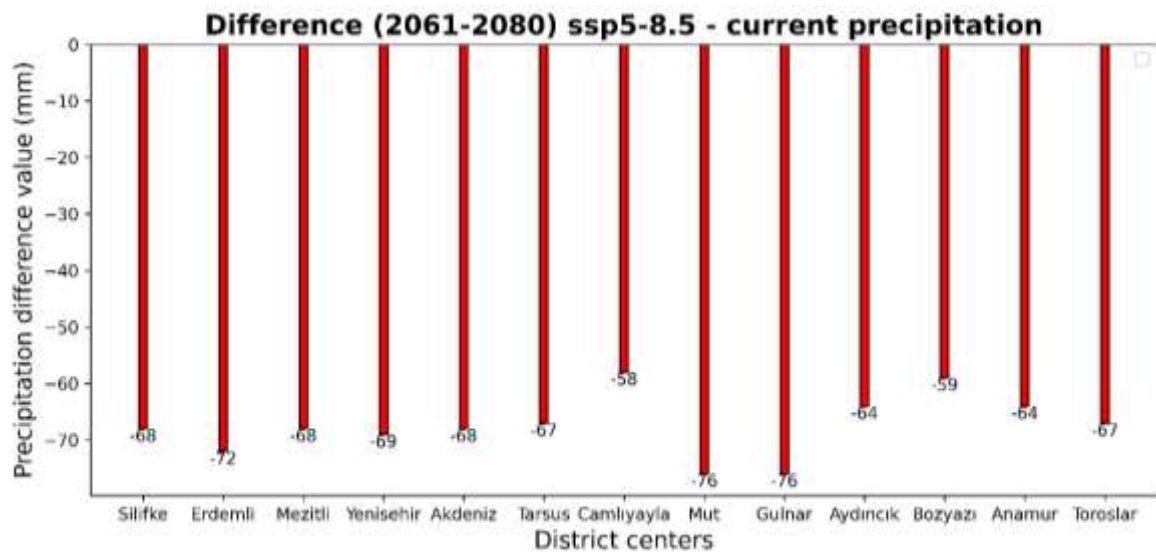


(b)

Figure 17. Differences between the data produced using the SSP2-4.5 and SSP5-8.5 scenarios for the period (2041-2060) and the current precipitation data

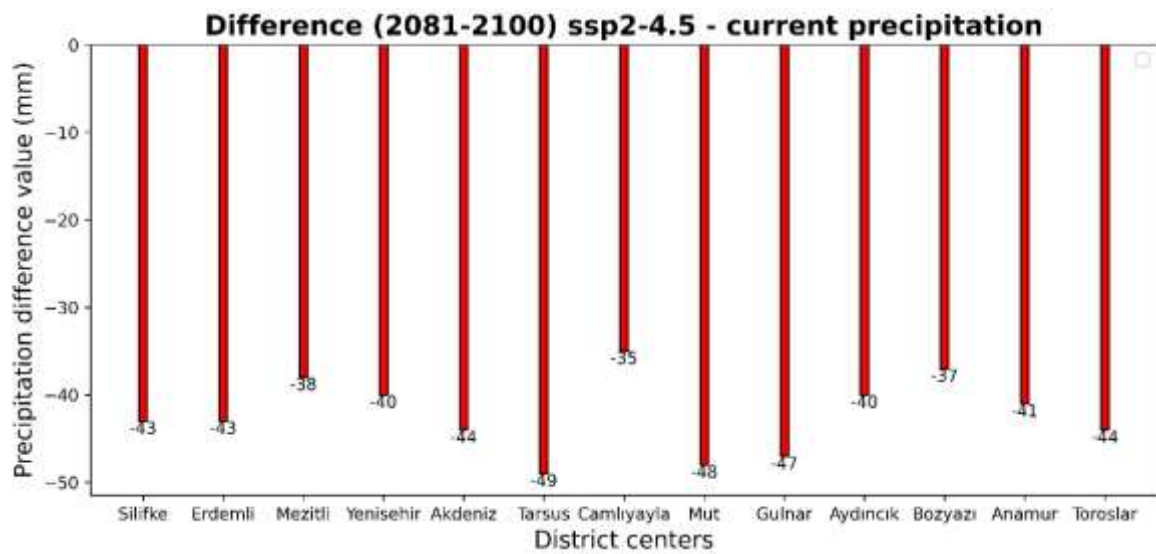


(a)

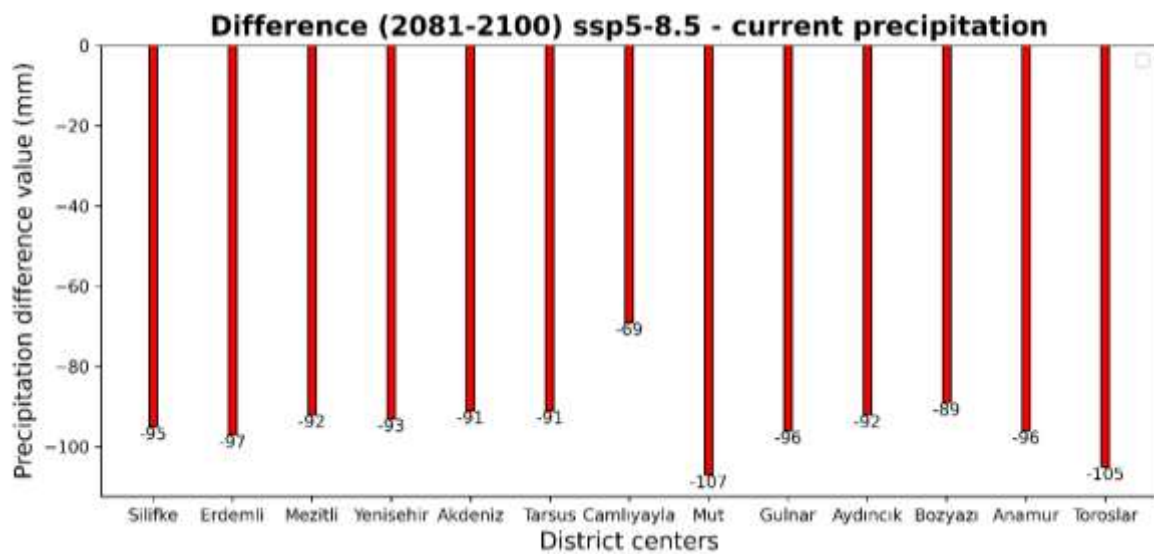


(b)

Figure 18. Differences between the data produced using the SSP2-4.5 and SSP5-8.5 scenarios for the period (2061-2080) and the current precipitation data



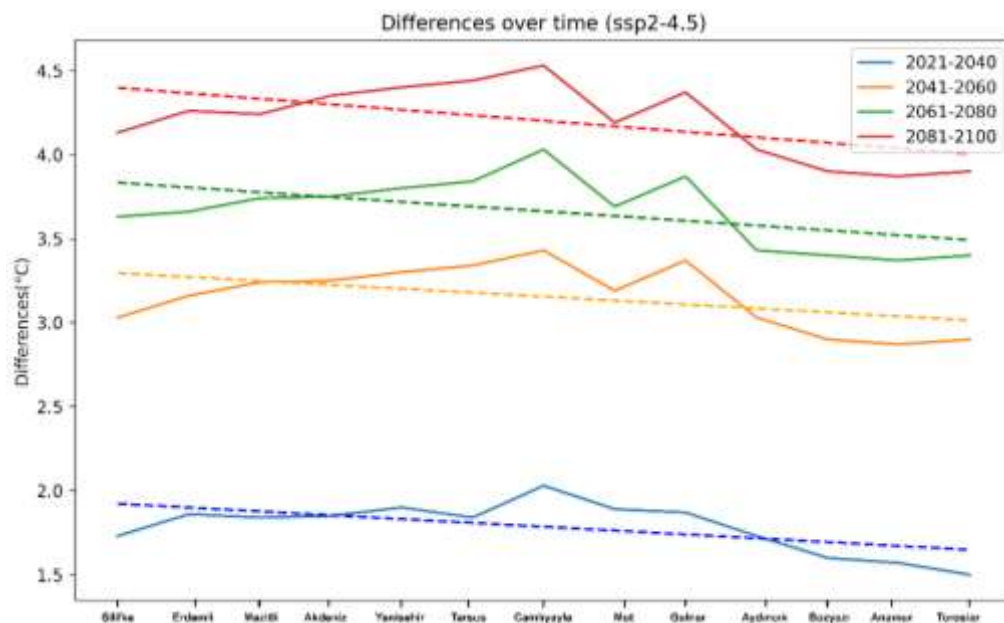
(a)



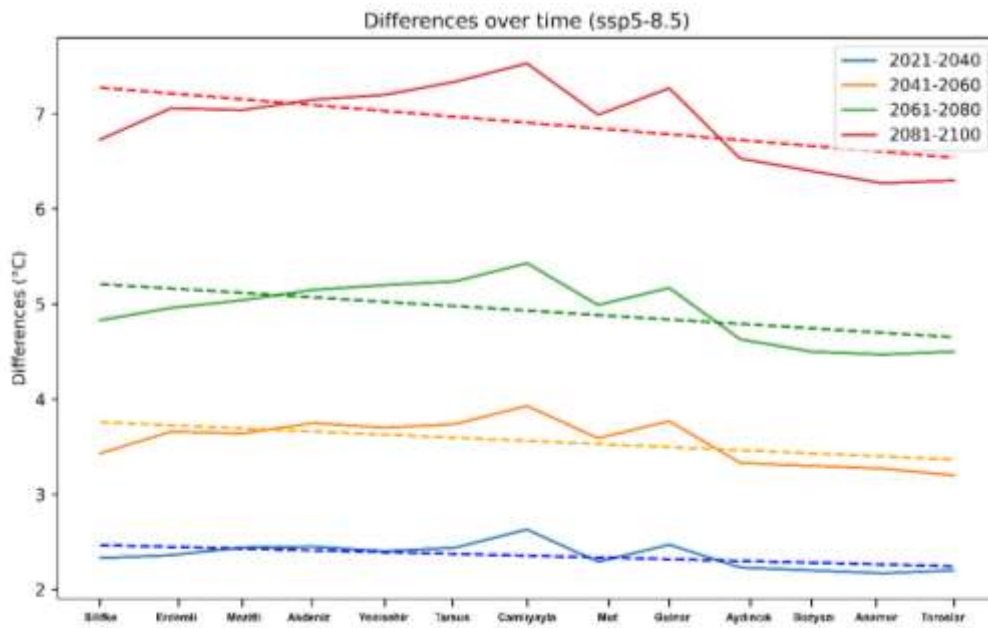
(b)

Figure 19. Differences between the data produced using the SSP2-4.5 and SSP5-8.5 scenarios for the period (2081-2100) and the current precipitation data

As a result of the analysis, it is seen that the temperature will rise and the precipitation will decline. The SSP2-4.5 scenario predicts a warming of around 3.2°C, whereas the SSP5-8.5 scenario predicts a warming of approximately 4.4°C by the end of the 21st century (Figure 20).



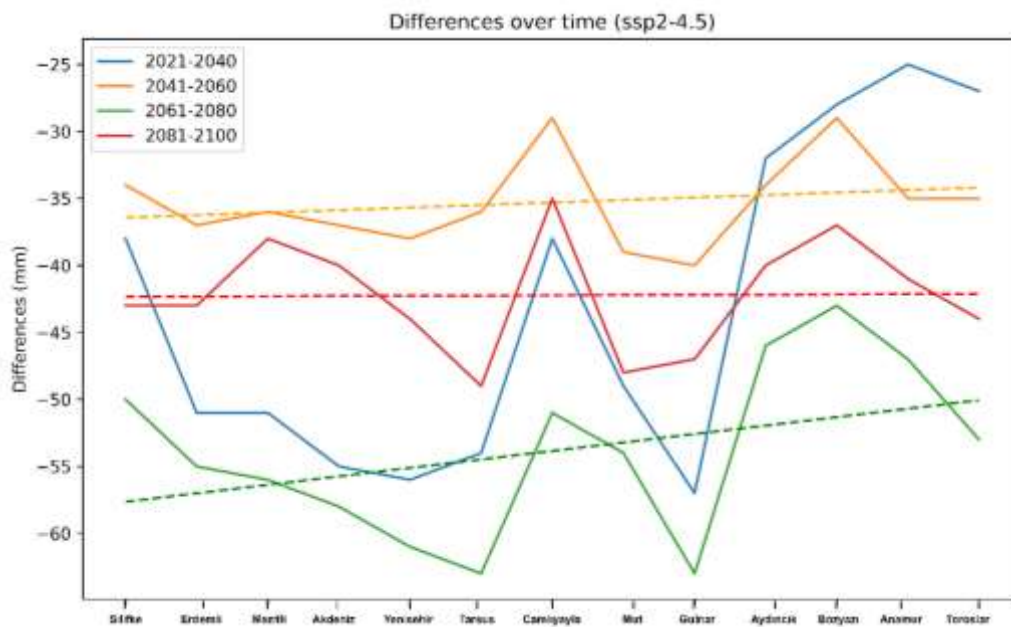
(a)



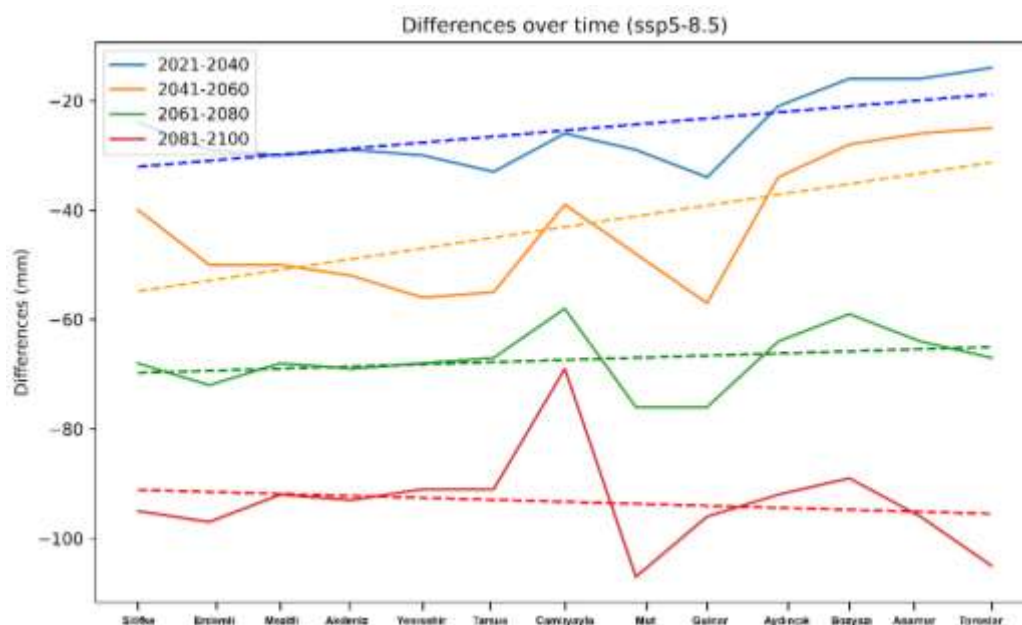
(b)

Figure 20. Change in temperature as per the SSP2-4.5 (a) and SSP5-8.5 (b) scenarios

It was established that precipitation levels would decline by 6.5% and 8.5% in turn to the SSP2-4.5 and SSP5-8.5 scenarios (Figure 21). The results demonstrated that climate change represents a significant risk to the study area.



(a)



(b)

Figure 21. Change in precipitation as per the SSP2-4.5 (a) and SSP5-8.5 (b) scenarios

CONCLUSION

It is vulnerable to the negative effects of global warming because it is located in the study area, the Mediterranean basin. The HadGEM3-GC31-LL global climate model and the SSP2-4.5 and SSP5-8.5 climate scenarios were used to determine the effects. Graphs were made after current and potential climate features were examined. Mersin's heightened susceptibility to climate change was disclosed by the application. The results of the study are expected to assist those making decisions in reducing the potential impact of the stated threat.

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**HEALING AND RESTORING THE SELF THROUGH NATURE: ECOCRITICAL
TENETS IN THE MOVIE *WILD***

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Abstract

From past to present, many researchers and scholars have suggested that being in touch with nature is highly effective in seeking mental health and self-discovery. This idea of nature's ability to cure human soul and restore inner self has also been reflected through literary pieces. As a suffering woman, whose mother dies unexpectedly, the American author, Cheryl Strayed writes down in a diary how she treats her wounded soul and finds her lost self through taking shelter in nature. In that sense, this present study explores how nature is represented as a medium to find true self in the movie *Wild* (2014) adapted from the memoir *Wild: From Lost to Found on the Pacific Crest Trail* written by Cheryl Strayed in 2012.

Focusing on the treatment of nature in the movie *Wild* from an ecocritical perspective, this study discusses how nature has a kind of healing power over human beings and it is the place, where an individual seeks his/her purest level of soul. Providing the opportunity to realize the intimate relationship between human and nature, the study attempts to demonstrate that man cannot be separated from nature instead, they should be integrated to one another.

As one of the touchstones of ecocritical studies, the concept of wilderness plays a vital role during the healing process since the main setting place is the Pacific Crest Trail throughout the film. Concordantly, the study examines this movie from an ecocritical perspective emphasizing the portrayal of wilderness with regard to the ideas of New World Romanticism and Deep Ecology within the conceptual framework of ecocriticism.

Key Words: *Wild*, nature, human, ecocriticism, healing

INTRODUCTION

The relationship between humans and environment has been a complicated issue regarding that such environmental problems as pollution, global warming, deforestation, extinction of certain species, and the hole in the ozone layer have been brought forth by human civilizations so far. With the advent of such destruction in the ecosystem, a necessity to raise an ecological consciousness in the human mind has emerged. Mirroring human-nature interactions, literature offers an opportunity to foster an ecological awareness in the human mind. Flourishing as a literary theory, ecocriticism, also known as green studies, delves into the relationship between literature and the natural environment aiming at establishing a kind of environmental consciousness by criticizing the destruction of nature by humankind and the separation of human beings from nature. Ecocriticism focuses on how the natural world, which consists of animals, plants, and landscapes, and ecological concerns are reflected through literature. It explores how the human-nature relationship is represented in literary pieces.

Within this regard, the present paper is an ecocritical study elaborating on the relationship between humankind and nature highlighting that human beings should not be disconnected from nature instead, they should be embedded within it. This paper scrutinizes the movie *Wild* (2014) based on Cheryl Strayed's memoir *Wild: From Lost to Found on the Pacific Crest Trail* through the ecocritical lens with a specific focus on the rebirth and restoration of this woman's soul through nature. It attempts to evince how nature, especially the concept of wilderness, and its intimacy with humans is depicted throughout the movie.

As an American writer and podcast host, born on 17th September 1968, Cheryl Strayed starts to lead her life together with her mother and siblings after her mother divorces her alcoholic husband mistreating both his wife and children. In the aftermath of her mother's marriage to another man named Glenn Lambrecht, they move to Aitkin County where they built their own house, which had no electricity or running water for the first several years. As an individual, who has gone through a series of difficulties since her little age, Cheryl's psychological state gradually deteriorates, however; the breaking point, which drastically affects her life, becomes her mother's sudden death because of lung cancer. Cheating on her husband constantly and turning into a drug addict, she seems to be unable to overcome the absence of her mother. Another turning point for Cheryl becomes the moment when she realizes that she is pregnant and she does not even know who the father of this baby is. This day, she decides to go for hiking along the Pacific Crest Trail to seek her true self through the healing power of nature as her mother advised her. Upon this vital decision, she hikes along the PCT starting from California to Washington for three months and during her journey, she writes down her memories and publishes them in 2012.

Directed by Jean-Marc Vallée and written by Nick Hornby and Cheryl Strayed, the memoir of Cheryl Strayed was adapted into a movie called *Wild* in 2014. The movie constitutes an ideal ground for giving the presence of nature with scenes full of mountains, oceans, rocks, forests, wild animals, and various climate conditions. Considering the scenes from the movie, it is often likely to come across diverse portraits of nature ranging from a dangerous one, in which human has difficulty in surviving, to a tender one in which man can find cure both mentally and physically. Depending on this observation and being aware that ecocriticism is a literary theory related to various disciplines, offering multifaceted views of nature, the film is quite appropriate to be discussed within the scope of some concepts belonging to ecocriticism.

Embracing the scenes involved in nature, the film provides the opportunity to realize the human-nature relationship manifesting that man cannot be separated from nature and the audience gets into the strong feeling that nature is the place where humans rediscover the inner self. Nature plays a key role in the path leading to freedom to find treatment for the soul. When spoken of nature, it becomes inevitable to underline how the concept of wilderness is described throughout the film. Concerning this, the present study deals with the concept of wilderness as a source of healing and finding the true self in regard to the perspectives of the Deep Ecology Movement, which take heed of the protection of wilderness.

Wilderness, in this movie, appears as a place where there is no human interference instead of being depicted as a place with human trace. Rejecting the integration of human culture with nature as Old World Romanticism puts forth, wilderness is portrayed as an untouched or uncontaminated place by human beings. Another crucial point to consider, which is again opposed to Old World Romanticism, wilderness is a place to escape for a short period. In addition to this, even though the main character of the movie is a woman, who achieves to survive in this place, wilderness is represented as a place for men, not for women. Within this context, this paper analyses nature according to New World Romanticism with reference to the concept of wilderness.

While touching upon the concept of wilderness, this study psychologically examines male and female characters' reactions and attitudes when experiencing wildlife with respect to the Cartesian way of thinking, which paves the way for shifting nature's identification from female to male. As well, it is enlightened that as a woman in the core of a place mostly peculiar to men, how Cheryl Strayed struggles for survival in her journey into the wilderness where only men can exist.

CONCEPTUAL FRAMEWORK

Coined by William Rueckert in 1987 in his essay "Literature and Ecology: An Experiment in Ecocriticism", the term ecocriticism simply refers to "the study of the relationship between literature and physical environment" (Glotfelty, 1996, p. xviii). Similarly, in his book, Gerrard describes ecocriticism as "the study of the relationship of the human and the non-human, throughout human cultural history and entailing critical analysis of the term 'human' itself" (2012, p. 5). Love remarks that different from other literary analyses, theory of ecocriticism embraces nonhuman as well as human contexts and notions (2003). In this regard, ecocriticism includes all living forms on earth, in contrast to traditional literary criticism, which confines the understanding of the world to human society. It explores the ways that narratives depict the interdependence, exploitation, and harmony of humankind with the natural environment. Underlining the interaction between literature and ecological concerns, ecocriticism engages in how nature, the relationship between humans and nature, and environmental ethics are conceptualized in literary works. The intention of ecocriticism is to promote a greater comprehension of the ways that literature influences our interactions and perspectives of the natural world.

One of the hallmarks of ecocriticism is to deconstruct anthropocentrism, which refers to the idea that humans are the most significant entities in the universe, and targets to provide an alternative way of being in the world. Proposing a more ecocentric perspective, ecocriticism recognizes the intrinsic value of all living forms in the ecosystem. In his analysis of conventional human-centered mindsets, which are unable to comprehend the embeddedness of human and non-human entities, Timothy Clark advocates for deconstructing the anthropocentric approach, since "it puts in crisis the lines between culture and nature, fact and value, and between the human and the geological and meteorological" (2015, p. 9)

In accordance with the purpose of this study, the deep ecology movement is another crucial point to illuminate. Emerged in 1972 and coined by the Norwegian philosopher Arne Naess, deep ecology appears as both philosophical and environmental movement dealing with human-nature interactions. As opposed to the anthropocentric worldview, striving for biocentric equality promoting equal rights, health, and balance for all living forms in the ecosystem, the deep ecology movement recognizes "biospherical egalitarianism" (Naess, 2005, p. 95). Unlike the established understanding of environmentalism, which glorifies nature for its usefulness for humankind, the deep ecology movement maintains that all living forms on earth have their intrinsic value regardless of their benefit. In a similar vein, Guha indicates that deep ecology attaches a remarkable importance to nature and its primary focus is to make an efficient change from an anthropocentric to a biocentric way of thinking (1987). According to Clark, deep ecology proposes a way of life, in which all living forms already embrace one another while creating the self, and this provides an individual to cultivate a more profound self (2011). Accordingly, wild nature is affirmed as a place one can restore and develop "deeper, truer or more authentic identity" (Clark, 2011, p. 25). It's "the place of freedom" where man can "recover the true selves" lost as a consequence of "artificial lives" and where man perceives "the world as it is" or knows who he really is (Cronon, 1966, p. 16).

Accepting wild nature as a source of recovery, deep ecology puts a great emphasis on the protection of uncontaminated wilderness and the reconstruction of the destroyed places in the natural environment (Guha, 1987). This concept of wilderness leads us to the idea of wilderness of New World Romanticism, which signifies nature as untouched by human interference (Gerrard, 2012). As a similar aspect to pastoral narratives, wilderness embodies the motifs of 'escape' and 'return' whereas they differ in their construction of nature, which means that wilderness is not suitable for a permanent living place with its "untamed landscapes" and the "sharp distinction between the forces culture and nature" (Gerrard, 2012, p. 67). In other words, it is never a long-settled place, but people will get back to civilized life after the experience of wilderness. Besides, it seems that culture and nature are no longer connected to one another, which means that people develop their own cultural identity depending on their wilderness.

The concept of wilderness is depicted as a place appropriate for men, not for women. This leads us to the ecofeminist ideology, which indicates that "the connection between the oppression of women and the despoliation of the natural environment" originate from the same agent, "man-centered thinking" (Marshall, 1993, p. 49). Opposing the conventional Western narratives, which associate nature with women and reason with man, Susan Bordo elucidates that Cartesianism, the philosophy of René Descartes emphasizing reason and rationality, in the seventeenth century brings along nature's identification with the "potentiality of disorder and the need for forceful male control" (1987, p. 109). To put it more explicitly, the traditional Western mindset and philosophy link rationality with masculinity while nature is connected with femininity, which is described as chaotic and irrational. Creating a kind of hierarchy and cultural superiority, this dualism paves the way for legitimizing the domination of both nature and women in their resemblance with the need to be controlled by the masculine power and this brings about a male-dominated nature. Correspondingly, untamed wild nature is identified with women, into which only a rational mind, namely man, can penetrate, rape, and surround.

ECOCRITICAL TENETS IN THE MOVIE *WILD*

The movie narrates the chronicle of Cheryl Strayed's one thousand one hundred miles her own hiking journey for three months along the Pacific Crest Trail undertaken in order to recover her mourning and grief after she lost her mother. Having lost her true self, Cheryl turns into an individual as opposed to what her mother taught her to be. Using drugs; cheating on her husband many times; getting pregnant; having her unborn child aborted; and lastly divorcing, Cheryl awakes to her degrading situation and makes a serious decision to shelter in nature to recruit and find her purest self when she gets a glimpse of the book on which written 'Pacific Crest Trail' with an amazing picture of nature:

CHERYL: I was strong. Responsible. I wanted things in my life. I was good, you know. Now, I am ruining the rest of my life. I am gonna go back to the store. I am gonna back myself, back to the woman my mother I was (Vallée, *Wild*, 00:40:10).

The deep ecological resonance in the movie is explained by the fact that the main character takes advantage of wilderness with the purpose to cure and find her lost self. As deep ecology indicates, having lost her true self as a result of her artificial life, Cheryl chooses a way of healing through being in the place of freedom embedded within other living creatures on earth. Being well aware that recognizing her true identity entails to be involved in every other organisms, Cheryl does her best to live integrated with them, even though she feels scared when she bumps into a wild animal,

she resists and tries to overcome her fear towards these animals. When she hears animal sounds near her tent, she repeats several times the sentence “I am not afraid” (Vallée, *Wild*, 00:19:48).

In addition to her fear against wild animals, she also experiences fear for men. As stated in the conceptual framework of this study, although our leading character is a woman, wilderness is represented as place native to men. In the twelfth day of her journey, when she meets Greg, one of guys hiking on the PCT, the conversation between them reveals that Cheryl is the only female one written on the hiking list:

GREG: Uh, hi! Cheryl Strayed?

CHERYL: Oh, hi! I... Do I know you?

GREG: I saw your name in the trail register. You're the only woman in there (Vallée, *Wild*, 00:36:03).

Along with depicting wilderness as a place private for man, the movie reflects the Cartesian thinking of man's desire to reign over or oppress nature and women. Bearing in mind that she may be confronted with a sexual assault since she is going to be the only woman in wilderness, Cheryl takes along a dozen of condoms when journeying into wilderness. When she stops by Kennedy Meadows to have a rest, a guy helps her to get rid of unnecessary things to lighten her huge backpack, in the meantime, she clarifies why she takes them with her stating that “what woman goes on a hike and brings twelve condoms” (Vallée, *Wild*, 00:47:14). She, indeed, faces with this kind of danger; fortunately, she is able to save herself from men's sexual oppression.

As well as sexual oppression, Cheryl is subjugated to psychological pressure by man during her journey. When she meets Greg before reaching to Kennedy Meadows, exhibiting a kind of obsessive attitude, he persists in putting her on getting through Sierra claiming that there'd be huge snowfall and nobody would pass there:

GREG: Yeah, we picked the wrong year, though. You, uh, by passing the Sierra?

CHERYL: Sure. I'll bypass anything. Should I?

GREG: Oh, it's completely socked in. Biggest snowfall in a decade or so. Yeah, nobody's getting through there (Vallée, *Wild*, 00:37:25).

Another significance of this movie in the context of deep ecology lies in that wilderness is depicted an untamed and uncontaminated place just as the deep ecology movement puts a high consideration on the preservation of these places. Nature is not described as “something that has been damaged by culture” (Lourens, 2016, p. 24). As a New World Romanticism point of view, human beings that are embedded in wild nature are free from their cultural boundaries. Throughout Cheryl's hike through nature, she does not “shave her legs or wear make-up or even take care of her personal hygiene” which simply points to the fact that she appears to be in “her purest form of herself stripped from all cultures necessities” (Lourens, 2016, p. 23).

Wilderness, in this movie, is represented as a place for escape and return. Cheryl goes into the nature to escape from the artificiality of her life. Cheryl does not come to wilderness for a constant living instead, her only purpose is to refresh her mind through the healing power of nature. On the fifth day of her journey, she expresses how she misses her ordinary life and points out that she will be back to the civilised life:

CHERYL: “What do you like to do when you're not hiking, Cheryl?” I like to sit on a real toilet. And flush. I like to cook food. Eat food with other people. People, that's another thing I like. I like talking to people. I like listening to people” (Vallée, *Wild*, 00:21:35).

The untouched wilderness offers Cheryl seclusion in solitude for a short period that she needs for the rediscovery of her lost self. Through this escape and return experience in wilderness, she gets the opportunity for self-reflection pondering over her past and future. In a sense, nature turns into a mirror revealing her inner conflicts and providing solutions in accomplishing her personal recovery. At the end of the movie, informing that she gets married and has two children after experiencing a kind of rebirth through nature, she goes back to her civilised life:

CHERYL: After I lost myself in the wilderness of my grief, I found my way out of the woods. And I didn't know where I was going until I got there on the last day of my hike. Thank you, I thought over and over again, for everything the trail had taught me, and everything I couldn't yet know. How, in four years, I'd cross this very bridge. I'd marry a man in a spot almost visible from where I was standing. How, in nine years, that man and I would have a son named Carver, and a year later, a daughter named after my mother, Bobbi (Vallée, *Wild*, 01:49:03).

Throughout the movie, during her trail on the PCT, the concept of nature has a great impact on the journey into her inner self. Her intimate connection with nature provides her the chance to recover from her psychological illness. By putting herself in the way of natural beauty just as her mother advises her, she manages to become a part of nature instead of estranging herself from it and she celebrates being fused with nature:

CHERYL: I knew only that I didn't need to reach with my bare hands anymore. That seeing the fish beneath the surface of the water was enough. That it was everything. My life, like all lives, mysterious, irrevocable and sacred. So very close. So very present. So very belonging to me. How wild it was... to let it be (Vallée, *Wild*, 01:49:52).

Lastly, the movie shows some ecocentric tendencies through the songs played throughout the movie. Such songs as *El Cóndor Pasa (If I Could)* by Simon and Garfunkel⁸ and *Walk Unafraid* by R.E.M.⁹ offer an insight into the close intimacy between human and nature. From an ecocritical perspective, these songs align with the movie's imposition of the harmonious relationship between humans and nature emphasizing that human should appreciate and love nature instead of exploiting, controlling, or fearing it. Reinforcing the portrayal of the natural environment as a source of healing power and foregrounding the spiritual bond between human and nature, the songs shed light on nature's strong influence on Cheryl Strayed's emotional as well as psychological transformation.

CONCLUSION AND DISCUSSION

This paper has focused on the concept of nature in the movie *Wild* from an ecocritical point of view. It has been concluded that nature has a kind of healing power over human beings by virtue of the fact that the main character, Cheryl could overcome her pain and sorrow through reunion with nature. It also has a great effect on her struggle with the crisis related to losing and finding true self.

Depicted as an untouched place, the concept of wilderness has been another attention of this paper. The concept of wilderness in this movie has been analysed depending on the ideas of New World Romanticism. It has been found out that wilderness is portrayed as a place for men based on the fact that this place is full of male hikers while the presence of women on the PCT consists of only Cheryl and the woman that she met on the trail. Besides, it has been unearthed that wilderness is a place,

⁸ Written in 1913, the composer of *El Cóndor Pasa* is Daniel Alomía Robles. Simon and Garfunkel cover was released in 1970 and this version is called *El Cóndor Pasa (If I Could)*.

⁹ *Walk Unafraid* is a song by American rock band R.E.M. released in 1998.

which is free from cultural identity regarding that the main character is acquitted of her cultural boundaries when in wilderness. As the last focal point, it has been determined that the songs have some ecological inclinations to emphasize nature as a source of healing in the restoration of the self.

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**DIGITAL TRANSFORMATION AND CIRCULAR ECONOMY AND: NEW
APPROACHES IN THE CONSTRUCTION INDUSTRY**

**DİJİTAL DÖNÜŞÜM VE DÖNGÜSEL EKONOMİ: İNŞAAT SEKTÖRÜNDE YENİ
YAKLAŞIMLAR**

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Abstract

The construction industry is renowned for its substantial energy consumption and significant dependence on natural resources. This situation greatly affects the construction process. The increasing importance of cutting-edge technological initiatives stems from their capacity to adopt sustainable solutions, improve efficiency, and minimize waste. The circular economy approach is a prominent sustainable solution in the economic realm, with its emphasis on environmental protection, waste reduction, and product longevity. Within the realm of technological advancements, digital technologies play a vital role in providing innovative solutions that yield economic advantages and contribute to a more sustainable future. These technologies aim to maximize resource efficiency, reduce waste, and address environmental concerns. Understanding and analyzing the interaction between the circular economy and digital technologies is of utmost importance, as it has a significant impact on the sector. There is ongoing discussion regarding the most effective features of digital technologies in supporting the circular economy, and how to develop these features within the sector's principles.

The aim of this study was to conduct a comprehensive literature review to identify the various challenges encountered during the process of digitalization and the integration of the circular economy model. In addition, we evaluated the degree to which this integration can meet sustainable construction standards and fulfill dual criteria. A recent study conducted using the Web of Science database examined various topics including 'circular economy AND (digitalization OR digital technologies)', 'circular economy AND construction sector', 'digital technologies AND construction sector'. The findings of this research provided valuable insights into the evaluation criteria. Implementing digitalization and integrating circular economy principles pose various challenges. Nevertheless, the construction sector can attain sustainability by skillfully integrating these two approaches.

Keywords: Digital transformation, circular economy, sustainability, construction industry

ÖZET

İnşaat sektörü, önemli miktarda enerji ve doğal kaynak tüketiminin gerçekleştirilmesine neden olan sektörlerin başında gelmektedir. Bu durumun bir etkisi inşaat süreçlerinde verimliliği artırmak ve atığı en aza indirmek amacıyla daha sürdürülebilir çözümlerin benimsenmesine yönelik yenilikçi teknolojik çabaların artan önemidir. Sürdürülebilir çözümlerin başında döngüsel ekonomi yaklaşımı öncelikli olarak çevrenin korunmasına odaklanıp, atık oluşumunu en aza indiren, ürün ve

malzemelerin ömrünü en üst düzeye çıkarmayı hedefleyen ekonomik bir strateji olarak yer alır. Teknolojik çaba bağlamında dijital teknolojiler ise kaynakların daha etkin bir şekilde kullanılmasını, atıkların azaltılmasını ve çevresel etkilerin en aza indirgenmesini amaçlayan hem ekonomik anlamda hem de daha sürdürülebilir bir gelecek için yenilikçi çözüm fırsatları sunmayı hedeflemesi bakımından önemlidir. Bu bakımdan döngüsel ekonomi ile dijital teknolojileri kesiştiren noktada bu iki gücün doğru bir şekilde okunup, kurgulamanın sektördeki etkileri açısından oldukça önemli olduğu görülmektedir. Dijital teknolojilerin hangi özelliklerinin döngüsel ekonomiyi desteklemede en etkili olduğu ve tüm bu özelliklerin farklı döngüsel ekonomi prensipleriyle sektörün sınırları içinde en etkili şekilde nasıl geliştirebileceği konusu hala tartışmalar yaratmaktadır. Çalışma kapsamında dijitalleşme süreci ve döngüsel ekonomi modeli entegrasyonunda karşılaşılan zorlukların neler olduğu ve bu entegrasyonun sürdürülebilir inşaat gereksinimlerini ne ölçüde karşılayabildiğinin belirlenmesine yönelik literatür taraması yapılmış, ikili karşılama ölçütleri değerlendirilmiştir. Tüm değerlendirme ölçütleri Web of Science veri tabanı bünyesinde son yıllarda öne çıkan araştırmalarla desteklenerek 'döngüsel ekonomi VE (dijitalleşme VEYA dijital teknolojiler)' 'döngüsel ekonomi VE inşaat sektörü', 'dijital teknolojiler VE inşaat sektörü', anahtar kelimeleri dikkate alınarak irdelenmiştir. Dijitalleşme ve döngüsel ekonomi entegrasyonunun uygulanmasında çeşitli zorlukların yaşandığı tespit edilmiştir fakat inşaat sektöründeki sürdürülebilirliğin iki yaklaşımın doğru entegrasyonu ile mümkün olabileceği görülmüştür.

Anahtar Kelimeler: Dijital dönüşüm, döngüsel ekonomi, sürdürülebilirlik, inşaat sektörü

GİRİŞ

Son yıllarda bilim ve iletişim teknolojilerinde yaşanan gelişmeler üretim süreçlerinde dikkate değer iyileştirmelerin yaşanmasını sağlamıştır. Teknolojide yaşanan bu gelişmeler arz alanında üretkenliği yükselterek üretim maliyetlerini düşürürken, diğer taraftan tüketimi de önemli ölçüde arttırmıştır. Bu durum sınırlı kaynakların hızlı bir şekilde tüketilmesini ve çevresel baskıların gün geçtikçe daha fazla artmasına yol açmıştır (Özsoy, 2018). Tüm bu etkiler aynı zamanda iklim değişikliği, çevresel kirlilik ve biyoçeşitlilik kaybı gibi oldukça ciddi sorunları da beraberinde getirmiş ve mevcut lineer ekonomi modelinin bu küresel sorunların çözümünde yetersiz kaldığını ortaya koymuştur (Ecer ve diğ., 2021).

Global Waste Management Market Overview 2024-2028 raporuna göre, son yıllarda atık yönetimi pazarında kentleşme, sanayileşme ve nüfus artışlarına paralel olarak oldukça önemli bir büyüme yaşanmıştır. Raporun devamında bu büyümenin devam edeceği öngörülerek, 2050 yılına kadar atık üretiminin %70 oranında artacağı ve 3,4 milyar metrik tona ulaşacağı belirtilmiştir (URL-1). Bu büyüme atık yönetimi pazarının sürdürülebilir ve yenilikçi çözümlere doğru yönelmesine yol açarak; geri dönüşüm ve atıkların enerjiye dönüştürülmesi gibi uygulamaların önemini arttırmıştır. Bu bağlamda literatürde atık krizi ile başa çıkmak ve sürdürülebilir bir gelecek yaratmak için lineer ekonomi modelden döngüsel ekonomi modele geçişin önemsendiği ve bu geçiş sürecinde dijital teknolojilerin etkin kullanılmasının önemine dikkat çekilmektedir (Şimşek, 2024).

Emek yoğun sektörlerden biri olan inşaat sektörü, ülke ekonomilerinin büyümesine ve kalkınmasına önemli katkılar sağlamaktadır (Avcı & Selçuk, 2020). Sektör, konut projelerinden altyapı projelerine kadar geniş bir dilimde çeşitli inşaat faaliyetlerini içermektedir (Daşkiran, 2023). Ayrıca enerji ve doğal kaynak tüketimi açısından önde gelen sektörler arasında yer alan inşaat sektörü (Gundes, 2016), her yıl üretilen 3 milyar ton atıkla dünya genelinde en fazla atık üreten sektör olarak öne çıkmaktadır (Eze ve diğ., 2024). Bu durum inşaat projelerinin performansını olumsuz yönde etkileyerek sektörde sürdürülebilir yaklaşımların ön planda tutulması gerekliliğini arttırmaktadır.

Benzer şekilde Cramer (2023) tarafından sektörün dünya genelindeki enerji tüketiminin %36'sını oluşturduğunu, atıkların %40'ını ürettiğini ve karbondioksit emisyonlarının yaklaşık %40'ına neden olduğu ifade edilmektedir (Cramer, 2023). Bu durum sürdürülebilir yaklaşımların önemini arttırmakta ve atığı azaltabilmek için inşaat sektöründe yeni sistemlerin geliştirilmesi ihtiyacını beraberinde getirmektedir (Jones & Yaman, 2020).

2014 yılından bu yana dijital teknoloji ve döngüsel ekonomi üzerine yapılan çalışmalar dikkat çekmeye başlamıştır (Awan ve diğ., 2021). Özellikle hızlı artan kentleşme ile birlikte inşaat faaliyetlerinde bakır ham maddelerin yoğun kullanımı, sürdürülebilir döngüsel ekonomi modeline olan ilgiyi artırmıştır (Banihashemi, ve diğ., 2023). Bu noktada dijital teknolojiler, üretim ve tüketimi döngüsel ekonomiye yönlendirmek için umut verici bir araç olarak görülmektedir. Ancak inşaat sektörünün teknolojiyi kullanma ve dijital dönüşüme adapte olma konusunda diğer sektörler göre geride kaldığına dair eleştiriler yapılmaktadır (Aladağ, 2022). Sektörde faaliyet gösteren birçok işletmenin geleneksel inşaat yöntemlerine bağlı kalması, mevcut altyapı ve ekipmanlarla ilgili operasyonel zorluklar döngüsel ekonomi ilkelerinin uygulanmasını güçleştirmektedir (Durdyev ve diğ., 2023; Giorgi ve diğ., 2022). Dolayısıyla yapılan çalışmalarda dijital teknolojilerin hangi özelliklerinin döngüsel ekonomiyi desteklemede en etkili olduğu ve bu özelliklerin döngüsel ekonomi stratejilerini nasıl geliştirebileceği konusunun hala netleşmediği görülmektedir (Liu ve diğ., 2022; Han ve diğ., 2023). Bu bakımdan çalışmada inşaat sektörü kapsamında belirlenen 2 temel hedef aşağıda yer almaktadır:

1. Dijital dönüşümün inşaat süreçleri üzerindeki etkilerinin gözden geçirilmesi,
2. Dijital teknolojiler ve döngüsel ekonomi modeli uygulamalarının birleştirilmesinde elde edilen avantajlar veya karşılaşılan zorlukların incelenmesi

KURAMSAL ÇERÇEVE

Dijital Dönüşüm Teknolojileri ve İnşaat Sektörü Üzerindeki Etkisi

Dijital dönüşüm teknolojileri ya da Endüstri 4.0 dönemi günümüzde yaşanan dijitalleşmenin ve üretim araçlarının organizasyonunda gerçekleştirilen yenilikler ile bir tür "Dijital Devrim" olarak tanımlanmaktadır (Türkel & Yeşilkuş, 2020). Bu dönüşüm tüm sektörlerde olduğu gibi inşaat sektöründe de önemli değişikliklere neden olmuş, proje süreçlerinin daha verimli yönetilmesi ve sürdürülebilir uygulamaların yaygınlaşması için bir fırsat yaratmıştır. Dijital dönüşümün temel amacı, bulut hizmetleri, nesnelerin interneti (IoT), büyük veri analizleri ve yapay zekâ gibi teknolojileri bir araya getirerek düşük maliyetle yüksek kaliteli üretimi optimize etmektir (Han ve diğ., 2023).

Dijital teknolojiler, bütün sektörleri etkisi altına aldığı gibi inşaat sektöründe de proje süreçlerinin daha etkin yönetilebilmesi amacıyla sektörde giderek daha fazla kullanılmaya başlandığı görülmektedir (Ceylan, 2019). Özellikle yapay zekâ, büyük veri, bulut bilişim, siber-fiziksel sistemler (CPS), blok zinciri (blockchain) ve sanal/artırılmış gerçeklik gibi teknolojilerin inşaat sektöründe yaygın bir şekilde uygulanmaktadır. Bu teknolojilerin sektörde uygulanması sektörün geleceğini iyileştiren yenilikçi çözümlerin üretilmesini sağlarken, çevresel sürdürülebilirlik bakımında da önemli katkılar sağlamaktadır. Özellikle inşaat faaliyetlerinin yapım ve yıkım işlemleri sırasında önemli miktarda ortaya çıkan katı atıkların doğrudan doğaya karışmaları doğaya büyük ölçüde zarar vermekte ve bu durum tüm canlılar için bir tehdit oluşturmaktadır (Akbaş & Çalışkan, 2023). Bu kapsamda Yapı Bilgi Modellemesi (BIM), malzeme pasaportları ve yaşam

döngüsü analizi gibi araçlar, inşaat süreçlerinin çevresel performansını şeffaflaştırarak bu tür sorunların çözümünde kilit bir role sahip olmaktadır (Eren, 2024).

Dijitalleşme sürecinin inşaat sektöründe gerçekleştirilmesini sağlayan dijital teknolojiler arasında Yapı Bilgi Modellemesi (BIM), malzeme pasaportları, nesnelerin interneti (IoT), yapay zeka (AI), sanal ve artırılmış gerçeklik, dijital ikizler ve bulut teknolojileri önemli bir yer tutmaktadır. BIM uygulaması bina yaşam döngüsü boyunca yapıya ait tüm bilgileri kullanmak üzere saklayan ve paydaşlar arasında işbirliği sağlayan bir veri deposu olarak işlev görmektedir (Aladağ, 2022). Bu dijital uygulama yapıdaki malzeme ve bileşenlerin özelliklerini, geri dönüştürülebilirlik ve tekrar kullanılabilirlik durumlarını analiz ederek, yapı elemanlarının sökülme aşamasında bu öğelerin nasıl ve nerede kullanılacağını planlayarak inşaat süreçlerinin çevresel performanslarını iyileştirmede etkili bir dijital platform sunmaktadır (Eren, 2024). Malzeme pasaportları yapı malzemelerinin yeniden kullanımını ve geri dönüşümünü sağlamak için verimli bir bilgi seti ve izleme süreci sağlayan dijital bir araçtır (Munaro & Tavares, 2021). Nesnelerin interneti (IoT) fiziksel cihazların veya veri akışını sağlayan aletlerin akıllı iletişim araçları veya internete bağlanması ile oluşmakta olan bir yapıdır (Erdal & Ergüzen, 2020). İnşaat faaliyetlerinde şantiye güvenliği, taşıyıcı elemanların takibi ve şantiyeye giren çıkan malzemelerin takibi gibi konularda katkı sağlayarak inşaat sahasında ekipman, malzeme ve iş süreçlerinin gerçek zamanlı izlenmesi ve yönetimi için kullanılmaktadır (Erol & Eraslan, 2024; Aladağ, 2022). Nesnelerin interneti (IoT) teknolojisi ayrıca yapı üretim süreçlerinde sürdürülebilirliği artırarak atıkların daha etkin bir şekilde yönetilmesini sağlamaktadır (Awan ve diğ., 2022). Sanal ve artırılmış gerçeklik yapı süreçlerinde 3D analizinin yapılmasını sağlayarak kaynakların etkin kullanımına katkı sağlamaktadır. Dijital ikizler ve 3D baskı gibi teknolojiler ise geleneksel yöntemlere göre CO2 emisyonunu ve enerji tüketimini azaltarak, malzeme verimliliğini artırarak sürdürülebilir alternatifler sunmaktadır (Cramer, 2023). Ayrıca, bulut teknolojileri, verilerin merkezi bir platformda depolanmasını ve işlenmesini sağlayarak, proje paydaşları arasında kolay veri paylaşımına olanak tanımaktadır. Bu teknolojiler, lojistik ve tedarik zinciri süreçlerini optimize ederek kaynak kullanımını ve atık yönetimi konularında da iyileştirmeler sağlamaktadır (Awan ve diğ., 2022). Dolayısıyla sektörde bu teknolojilerin kullanımı, atık azaltma, karbon emisyonlarını düşürme ve projelerin çevresel performansını izleme gibi alanlarda oldukça önemli faydalar sağlamaktadır (Rosário ve Dias, 2022). Tüm bu faydaların yanı sıra dijitalleşme döngüsel ekonomi ilkelerinin uygulanmasında da önemli bir rol oynamaktadır. Döngüsel ekonomi, "al-kullan-at" modeline alternatif olarak, kaynakların daha verimli kullanıldığı, atıkların en aza indirildiği ve ürünlerin ömrünün uzatıldığı bir model olarak tanımlanmaktadır (Pagoropoulos ve diğ., 2017). Dijital dönüşüm, bu süreçlerin her bir aşamasında verimliliği artırarak, çevresel etkileri minimize ederek döngüsel ekonominin uygulanmasını desteklemektedir (Stahel, 2016).

İnşaat Sektöründe Döngüsel Ekonomi Kavramı ve Dijital dönüşüm

Tüm dünyayı etkisi altına alan Covid-19 salgını, çevre kirliliği, iklim değişikliği, doğal kaynakların hızla tükenmesi gibi küresel sorunlar, mevcut lineer ekonomi modeliyle toplumların ihtiyaçlarının karşılanmasını güçleştirmeye başlamıştır (Yılmaz, 2022). Bu nedenle dünyada lineer ekonomi modeli anlayışı olan "al-yap-at" modeline alternatif olarak, israftan kaçınmayı hedefleyen bir model olarak döngüsel ekonomi modelinin gündeme geldiği görülmektedir. Döngüsel ekonomi, kavram olarak iyileştirici ve onarıcı bir ekonomi olarak tanımlanmakta ve çevrenin korunmasını odak noktasına alarak ürünlerin yaşam döngüsünün iyileştirilmesini amaçlayan kapalı döngü sistemlerini hedefleyen bir üretim-tüketim modelidir (Pagoropoulos ve diğ., 2017). Buna ek olarak modelin özellikle inşaat sektöründe benimsenmesi, sürdürülebilir yapıların inşası ve doğal kaynakların

korunması açısından oldukça önem taşımaktadır. Sektörün yüksek enerji tüketimi ve atık üretimi ile önemli çevresel etkiler oluşturmakta olup; döngüsel ekonomi ilkeleri bu etkilerin azaltılmasında kilit bir rol oynamaktadır (Stoiljković ve diğ., 2023).

Dijitalleşme, lojistik ve tedarik zinciri süreçlerini optimize ederek kaynak kullanımı ve atık yönetimi konularında iyileştirmeler sağlamaktadır. Dijital teknolojiler, bu süreçlerde verimliliği artırmakta ve çevresel etkileri minimize etmektedir (Awan ve diğ., 2022). Böylelikle, hammaddeden yeni mallar üretmek yerine üretim mantığını yeniden kullanıma, yeniden kullanılmayana geri dönüştürmeye, kırılanları onarmaya ve onarılamayanı yeniden üretmeye odaklanılarak doğal kaynakların yaşam döngüsü boyunca sürdürülebilir bir şekilde yönetilmesini sağlamaktadır (Stahel, 2016). Bu bağlamda inşaat sektöründe dijital dönüşüm araçlarının döngüsel ekonomi ilkelerini destekleyecek şekilde uygulanması, yapıların tasarımından atık yönetimine kadar tüm süreçlerde çevresel sürdürülebilirliğin sağlanmasına katkıda bulunabileceği öne sürülmektedir (Meng ve diğ., 2023). Buna ek olarak, modelin gayrisafi yurtiçi hasılatın büyümesi, net malzeme tasarrufunun sağlanması, istihdam edilen iş gücünün artırılması ve malzeme fiyatlarındaki dalgalanmalar ile tedarik risklerinin azaltılması gibi ekonomik avantajlar da sunduğu öngörülmektedir (Adams ve diğ., 2017). Günümüzde Amerika Birleşik Devletleri, İngiltere, Fransa, Hollanda ve Danimarka gibi gelişmiş ülkelerde, inşaat endüstrisinin üretim modelini döngüsel ekonomi modeline geçirme zorunluluğunu öngörülmüş ve döngüsel ekonomi modeli prensiplerini uygulamaya başlamışlardır (Eze ve diğ., 2024).

Döngüsel ekonomi modelinin, lineer ekonomi modelinden farklı olarak üretim ve tüketim süreçlerinin her bir safhasında “geri dönüşüm”, “yeniden kullanım”, “azaltma” olarak 3 temel işleyiş stratejisi bulunmaktadır. Geri dönüşüm, atık malzemelerin doğrudan yeniden kullanıma uygun hale getirilmesi veya atık kazanım süreçlerinin verimli bir şekilde işletilmesi anlamına gelmektedir. Yeniden kullanım ise, atıkların onarılarak, yenilerek veya yeniden üretilerek ya tamamen aynı amaçla ya da farklı ürünlerin üretiminde bir kısmının değerlendirilmesini ifade etmektedir. Azaltma ise üretim ve tüketim süreçlerinde ortaya çıkan atıkların çevre zarar verebilecek madde miktarının azaltılması anlamına gelmektedir (Önder, 2018). Şekil 1’de lineer ekonomi ve döngüsel ekonominin işleyişi gösterilmiştir.



Şekil 1. Lineer (Solda) ve Döngüsel (sağda) ekonomi modelinin işleyişi (Kaynak: Yaş, 2019)

Döngüsel ekonomi modelinin üç temel işleyiş stratejisinin inşaat sektörüne entegrasyonu sektör açısından büyük bir önem arz etmektedir. Özellikle geri dönüşüm ve yeniden kullanım süreçleri, yapıların yaşam döngüsünü uzatmakta ve inşaat atıklarının azaltılmasına önemli katkılar sağlamaktadır (Ruiz ve diğ., 2020). Örneğin kompozit atıkların çimento sektöründe alternatif yakıt olarak kullanılması, bu atıkların enerji ve ham madde olarak %100 oranında geri kazanılmasını mümkün kılmaktadır. İşlem sırasında, atıklardaki mineral bileşenler çimento üretimi için kullanılmakta, organik polimer matrisler ise fosil yakıtlara alternatif olarak değerlendirilmektedir. Almanya'daki endüstriyel ölçekli tesisler, yıllık 30.000 ton kapasiteyle, özellikle kullanılmış rüzgar türbini bıçaklarından elde edilen atıkları çimento fabrikalarına taşımaktadır. Bu sayede atık yönetiminde sıfır depolama hedefine ulaşılmasına katkıda bulunurken, çevresel sürdürülebilirlik açısından da önemli faydalar sağlamaktadır (Krauklis ve diğ., 2021).

Mangialardo ve Micelli (2018) inşaat sektöründe uygulanan döngüsel ekonomi modelini ilkelerini iç içe geçmiş bir daire şeklinde belirtmiştir (Şekil 2).



Şekil 2. İnşaat sektöründe uygulanan döngüsel ekonomi modelini prensipleri (Kaynak: Mangialardo & Micelli (2018))

Döngüsel ekonomi modeli sürecinde en tercih edilen müdahale binayı korumaktır çünkü bu yöntem en az müdahale gerektiren ve en fazla kaynak tasarrufu sağlayan seçenektir. Bu süreci takip eden daha fazla müdahale gerektiren yeniden donatma ve yenilenme işlemleridir. Daha karmaşık işlemler bileşenlerin geri kazanılmasını veya yeniden üretilmesini kapsarken; en zor işlem ise binaların geri dönüştürülmesidir (Mangialardo & Micelli, 2018). Ayrıca yazarlar bu süreçte göz önüne alınması gereken 5 temel tasarım ilkesi bulunduğunu belirterek; bu 5 temel tasarım ilkesinin yapıların esnek, sürdürülebilir ve uzun ömürlü olmalarına katkı sağladığını ifade etmişlerdir. Bu 5 temel prensip aşağıda sıralanmaktadır (Mangialardo & Micelli, 2018):

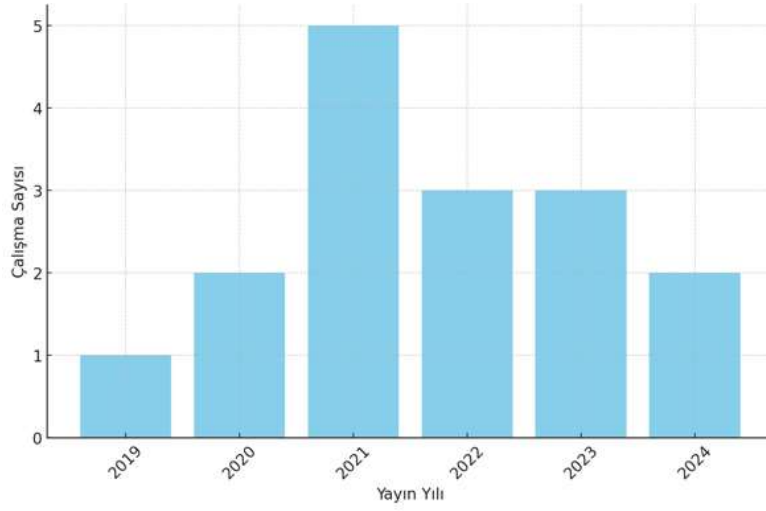
- **Katmanlar halinde inşa etme:** Bina elemanlarının farklı ömürlerini dikkate alarak değişim veya hasar durumunda kolayca değiştirebilmek ve uzun süre kullanımını sağlamak için eleman için ayrı katmanların planlanması
- **İsrafi ortadan kaldırma:** Atıkları yeni kaynaklar olarak görerek, tamir ve yenilemeyi yıkıma tercih etmek.
- **Uyarlanabilirlik için tasarım:** Binaları gelecekte farklı kullanımlara kolayca uyarlanabilmek.
- **Demonte edilebilirlik için tasarım:** Bina elemanlarının kolayca sökülüp başka yerlere taşıyabilmek.
- **Doğru malzeme seçimi:** Malzemeleri biyolojik ve teknik olarak ayırarak, geri dönüşüm sürecini kolaylaştırmak ve yeni pazarlar oluşturmak.

Dijitalleşme, lojistik ve tedarik zinciri süreçlerini optimize ederek kaynak kullanımı ve atık yönetimi konularında iyileştirmeler sağlamaktadır. Dijital teknolojiler, bu süreçlerde verimliliği artırmakta ve çevresel etkileri minimize etmektedir (Awan ve diğ., 2022). Böylelikle, hammaddeden yeni mallar üretmek yerine üretim mantığını yeniden kullanıma, yeniden kullanılmayana geri dönüştürmeye, kırılanları onarmaya ve onarılmayı yeniden üretmeye odaklanılarak doğal kaynakların yaşam döngüsü boyunca sürdürülebilir bir şekilde yönetilmesini sağlamaktadır (Stahel, 2016). Dijital teknolojilerin entegrasyonu ile bu döngüsel ekonomi prensiplerinin inşaat sektörüne uygulanması daha verimli ve izlenebilir hale getirilebileceği öngörülmektedir. Örneğin, nesnelerin interneti (IoT) gibi dijital uygulamalar, tesislerin ömrünü uzatmak, malzeme israfını azaltmak ve sürdürülebilirlik hedeflerine ulaşmak için tasarım süreçlerinin daha verimli hale getirilmesine imkan sağlamaktadır (Kineber, 2024). Ancak literatürde inşaat sektöründe bu entegrasyonun başarılı bir şekilde gerçekleştirilmesinin zorlu olabileceği buna rağmen bu entegrasyonun uzun vadede önemli faydalar sağlayabileceği belirtilmektedir (Meng ve diğ., 2023).

METODOLOJİ

Verilerin Toplanması ve Analizi

Bu çalışma 2019'dan 2024'e kadar inşaat sektöründe dijital teknoloji ve döngüsel ekonomi modeli üzerine yapılan araştırmaları analiz ederek dijital teknolojilerin döngüsel ekonomi modeli üzerindeki etkisi incelenmiştir. Değerlendirme ölçütleri için Web of Science veri tabanından yararlanılarak literatür taraması yapılmıştır. Literatür taraması boyunca anahtar kelimeler olarak; 'döngüsel ekonomi VE (dijitalleşme VEYA dijital teknolojiler)', 'döngüsel ekonomi VE inşaat sektörü', 'dijital teknolojiler VE inşaat sektörü', kullanılmış ve başlıklarda aranmıştır. Yapılan tarama sonucunda 1000'den fazla çalışma bulunmuş ve değerlendirmeler yapılarak bu sayı 68'e düşürülmüştür. Daha sonrasında uygunluk açısından ve içerik kontrolü yapıldıktan sonra bu sayı 16'ya indirgenmiştir. Şekil 3 yıllara göre yayınlanan bu makalelerin özetini göstermektedir.



Şekil 3. Yıllara göre yayınlanan makale sayısı

Çalışmada Web of Science veri tabanı bünyesinde son beş yılda öne çıkan araştırmalarla desteklenerek yapılan literatür taraması kapsamında dijitalleşme ve dögüsel ekonomi entegrasyonun uygulanmasına yönelik incelenen her bir makalenin özet analizleri Tablo 1’de yer almaktadır.

Tablo1. Dijital Teknolojilerin Döngüsel Ekonomi Üzerindeki Etkileri

Yazar(lar)	Yayın Yılı	Dijital Teknolojiler	Döngüsel Ekonomiye Katkılar	Karşılaşılan Zorluklar
Çetin ve diğ.	2021	BIM, malzeme pasaportları	Döngüsel ekonomiye katkı sağlamada kilit bir rol oynadığı görülmüştür.	Veri yönetimi ve işbirliği süreçlerinde belirsizlikler.
Giorgi ve diğ.	2022	BIM, malzeme pasaportları	Döngüsel ekonomi modelini destekleyici özelliklere sahip olduğu görülmüştür.	Yasal düzenlemeler ve politikaların eksikliği ve sınırlı kullanım.
Krauklis ve diğ.	2021	Mekanik, kimyasal, termal, çimento fırın yönetimi	Döngüsel ekonomiye destekleyici özelliklere sahip olduğu görülmüştür.	Yüksek enerji tüketimi, yüksek maliyetler, teknolojik uyum zorlukları.
Torgautov ve diğ.	2021	BIM	BIM aracının döngüsel ekonomiye destekleme potansiyeline sahip olduğu görülmüştür.	Ekonomik motivasyon eksikliği, risk alma konusundaki çekinceler.
Talla & McIlwaine	2024	Eklemeli/robotik üretim, yapay zeka, büyük veri, blok zinciri (blockchain), BIM, dijital platformlar, dijital ikizler, coğrafi bilgi sistemi, malzeme pasaportları, nesnelerin internet (IoT)	İnşaat sektöründe malzeme geri dönüşüm oranlarını iyileştirme ve gereksiz atıkları azaltma etkisi olduğu görülmüştür.	Dijital teknoloji yetenek farkları, işbirliği zorlukları.
Zandee ve diğ.	2022	BIM, blok zinciri (blockchain)	Yönetimsel stratejiler geliştirilmiş ve dijital teknoloji araçlarının enerji tüketiminin azaltılmasında, malzeme seçimi ve tasarım süreçlerinin optimize edilmesinde, bileşenlerin sökülebilirliğinin artırılmasında döngüsel ekonomi ilkelerine önemli katkılar sunduğu görülmüştür.	Lineer modelden döngüsel modele geçişte zorluklar.
Meng ve diğ.	2023	Dijital ikizler	Döngüsel ekonomi ile entegrasyonu atık miktarını azaltma, malzemelerin yeniden kullanımında etkili olduğu görülmüştür	Henüz emekleme aşamasında olduğu ve küçük firmaların bu stratejileri uygulamada karşılaştıkları zorluklar.
Rosa ve diğ.	2019	Eklemeli üretim, büyük veri, nesnelerin internet (IoT) Siber-fiziksel sistemler (CPS)	Geri dönüşüm ve yeniden üretim süreçlerini iyileştirme gibi konularda etkili olduğu görülmüştür	Küçük ve orta ölçekli firmalar için yüksek maliyet ve karmaşıklık gibi sorunlar.
Kurniawan ve diğ.	2022	Bulut teknolojisi	Atık yönetiminde dijitalleşmenin, atık oluşumunu %65 oranında azalttığını ve geri dönüşüm süreçlerinin daha verimli	Dijital altyapı yetersizlikleri, veri güvenliği ve gizlilik endişeleri. Ayrıca küçük ve orta ölçekli firmaların uyum sorunları.

			hale getirildiği sonucu elde edilmiştir	
Nara ve diğ.	2021	Nesnelerin interneti (IoT), siber-fiziksel sistemler (CPS), büyük veri	Atık izleme, kaynak verimliliği, çevresel etkileri azaltma gibi konularda katkı sağladığı görülmüştür	Enerji tüketimi, yüksek maliyetler, veri güvenliği endişeleri
Ghobakhloo	2020	Nesnelerin interneti (IoT), siber-fiziksel üretim sistemleri (CPPS)	Kaynak verimliliğini iyileştirme, atık miktarını azaltma gibi konularda katkı sağladığı görülmüştür	Yüksek maliyetler, siber güvenlik riskleri
Hao ve diğ.	2020	BIM tabanlı prefabrikasyon uygulamaları	BIM'in karbon emisyonlarını ölçme konusunda oldukça etkili bir dijital araç olduğu ve prefabrikasyon uygulamalarının karbon emisyonlarını geleneksel dökme yerinde inşaat yöntemlerine göre önemli ölçüde azaltabileceği tespit edilmiştir	Hükümet politikalarının prefabrikasyon kullanımını teşvik etmesi gerekliliği
Munaro ve Tavares	2021	Malzeme pasaportları	Geri kazanım ve yeniden kullanım iyileştirmeleri	Dijital veri yönetim platformları geliştirme ihtiyacı gerekliliği
Jemal ve diğ.	2023	BIM, nesnelerin internet (IoT), büyük veri, bulut bilişim, dijital ikizler, 3D baskı	Kaynak verimliliği artırma, atık azaltma, çevresel sürdürülebilirliği desteklediği sonucu elde edilmiştir	Yüksek maliyetler, veri güvenliği endişeleri, veri entegrasyonu zorlukları
Banihashemi ve diğ.	2023	BIM, dijital ikizler, malzeme pasaportları, radyo frekansı tanımlama (RFID), blok zinciri (Blockchain), oyunlaştırma	Verimlilik, güvenlik, sürdürülebilirlik konularında katkılar sağladığı görülmüştür.	Dijitalleşmenin yetersizliği, retrofit dijitalleşme maliyetleri
Charef	2024	BIM, dijital ikizler, nesnelerin interneti (IoT)	Kaynak verimliliği, atık yönetimi, veri toplama ve yönetim süreçlerine katkı sağladığı görülmüştür	Yüksek maliyetler, veri entegrasyonu zorlukları, kullanıcı uyumu zorlukları

BULGULAR

Çalışma kapsamında elde edilen bulgular inşaat sektöründe dijital teknolojilerin döngüsel ekonomi üzerine etkilerini araştıran çalışmaların, bu teknolojilerin potansiyelini ve uygulama süreçlerinde karşılaşılan zorlukları ortaya koyduğunu göstermektedir. Çetin ve diğ., (2021) tarafından “eklemeli/robotik üretim”, “yapay zeka”, “büyük veri”, “blok zinciri teknolojisi (blockchain)” “BIM”, “dijital platformlar”, “dijital ikizler”, “coğrafi bilgi sistemi”, “malzeme pasaportları”, “nesnelerin interneti (IoT)” olmak üzere 10 adet dijital teknolojilerden hangilerinin yapılı çevrede döngüsel ekonomiyi destekleyebileceği ve bu teknolojilerin döngüsel ekonomiye olan katkıları değerlendirilmiştir. Yazarlar çalışma sonucunda BIM ve malzeme pasaportları gibi dijital teknolojilerin döngüsel ekonomiyi destekleyici katkı bir rol oynadığını, ancak bu teknolojilerin

etkin bir şekilde uygulanmasında veri yönetimi ve işbirliği süreçlerinde karşılaşılan belirsizlikler gibi engellerin dijital teknolojiye geçiş sürecini zorlaştırdığını tespit etmişlerdir (Çetin ve diğ., 2021). Benzer bir çalışma Giorgi ve diğ., (2022) tarafından yapılmış ve Avrupa'daki beş ülkede (Belçika, Hollanda, Birleşik Krallık, Danimarka, İtalya) inşaat sektöründe BIM ve malzeme pasaportları gibi dijital teknolojilerin döngüsel ekonomi modelini destekleyici özelliklere sahip olduğunu bununla birlikte bu teknolojilerin kullanımının sınırlı olduğu ve bu araçların kullanımının teşvik edilmesi gerektiği sonuçları elde edilmiştir. Yazarlar ayrıca döngüsel ekonomiyi destekleyici yasal düzenlemeler ve politikalara ihtiyaç duyulduğunu belirtmişlerdir (Giorgi ve diğ., 2022).

Krauklis ve diğ., (2021) tarafından kompozit malzemelerin geri dönüşümüne yönelik mevcut teknolojilerin döngüsel ekonomi üzerindeki etkilerinin değerlendirilmesine yönelik bir çalışma gerçekleştirilmiştir. Yazarlar çalışma sonucunda kompozit malzemelerin geri dönüşümünde kullanılan teknolojilerinin döngüsel ekonomiyi destekleyici özelliklere sahip olduğunu ancak bu teknoloji kullanımlarının yaygınlaşması için daha fazla teşvik ve yasal düzenlemelerin gerekliliğine dikkat çekmişlerdir. Bununla birlikte çalışmada bu teknolojilerin yüksek enerji tüketimi, maliyetler ve teknolojik uyum gibi engellerin karşılaştığını döngüsel ekonomi hedeflerine ulaşılabilmesini güçleştirdiği belirtilmiştir (Krauklis ve diğ., 2021). Bir başka çalışma Torgautov ve diğ. (2021) tarafından Kazakistan inşaat sektöründe gerçekleştirilmiştir. Çalışmada yerel paydaşların inşaat malzemelerini yeniden kullanma yada çevre dostu teknolojileri benimsemeye yönelik kararlarının, bu uygulamaların ekonomik bir katkı sağlayıp sağlamadığını değerlendirerek verdikleri sonucu elde edilmiştir. Araştırmacılar bu bakımdan ekonomik motivasyonların, döngüsel ekonomi modelinin benimsenmesinde önemli bir faktör olduğunu ve inşaat şirketlerinin karlarını etkileyen risklerin bu süreçte belirleyici bir faktör olduğunu tespit etmişlerdir. Buna ek olarak yazarlar, Kazakistan inşaat sektöründe BIM aracının döngüsel ekonomi uygulamalarında önemli bir potansiyele sahip olduğunu vurgulamıştır (Torgautov ve diğ., 2021).

Dijital teknolojilerin atık yönetimi üzerindeki etkileri de literatürde geniş yer bulmuştur. Talla & McIlwaine (2024), inşaat atıklarını azaltma ve geri dönüşümü iyileştirme amacıyla kullanılan dijital teknolojilerin etkilerini incelemiş ve proje paydaşlarının dijital yeteneklerindeki farklılıkların uygulamada zorluklar yarattığını belirtmiştir (Talla & McIlwaine, 2024). Zandee ve diğ., (2022), BIM ve blok zinciri (blockchain) gibi teknolojilerin enerji tüketiminin azaltılması, malzeme seçimi ve tasarım süreçlerinin optimize edilmesi, bileşenlerin sökülebilirliğinin artırılması gibi döngüsel ekonomi ilkelerine önemli katkılar sunduğunu vurgulayarak, bu teknolojilerin, sürdürülebilirlik ve kaynak verimliliğini artıran özelliklere sahip olduğunu belirtmişlerdir. Ancak yazarlar başarılı bir uygulama için şirketler arası işbirliği ve farkındalık yaratmanın önemli olduğunu vurgulamıştır (Zandee ve diğ., 2022). Meng ve diğ., (2023) tarafından dijital ikizlerin döngüsel ekonomi ilkelerinin inşaat sektöründe atıkların azaltılmasına ve yeniden kazanım değerinin artırılmasına yönelik destekleyici özelliklere sahip olduğunu belirtilerek, döngüsel ekonomi stratejileri açısından tasarım ve yıkım aşamalarının diğer proje aşamalarından daha önemli olduğu öne sürülmüştür. Buna ek olarak yazarlar bu teknolojinin henüz emekleme aşamasında olduğuna dikkat çekerek, bu alanda daha fazla araştırma yapılmasının gerekliliğini vurgulamışlardır (Meng ve diğ., 2023). Rosa ve diğ., (2019) tarafından yapılan bir diğer çalışmada ise dijital teknolojilerin geri dönüşüm süreçlerini iyileştirdiğini ve kaynakların verimli kullanımına katkı sağladığını göstermiştir. Ayrıca yazarlar dijital teknoloji ve döngüsel ekonomi entegrasyonunun pratikte nasıl uygulandığına yönelik daha fazla ampirik kanıtı ihtiyaç duyulduğunu belirtmiştir (Rosa ve diğ., 2019).

Kurniawan ve diğ., (2022) tarafından Endonezya'da atık geri dönüşümünün dijitalleşme yoluyla nasıl gerçekleştirilebileceğini ve bunun döngüsel ekonomi üzerindeki etkilerinin değerlendirilmesine yönelik bir çalışma gerçekleştirilmiştir. Çalışma sonucunda bulut teknolojisi

gibi araçların atık geri dönüşüm süreçlerini optimize ederek kaynak geri kazanımlarını sağlayarak döngüsel ekonomiye katkıda bulunduğu görülmüştür. Ayrıca çalışmada dijital alt yapı yetersizlikleri ve bu teknolojilerin benimsenmesindeki direnç dijital dönüşüm sürecinde özellikle küçük ölçekli firmalar açısından karşılaşılan zorluklar arasında olduğu belirtilmiştir. Bu zorluklara ek olarak dijital teknolojilerin veri güvenliği ve gizlilik konularındaki endişeler de paydaşlar açısından bir engel oluşturduğu vurgulanmıştır (Kurniawan ve diğ., 2022). Nara ve diğ., (2021) tarafından yapılan bir başka çalışmada ise özellikle nesnelerin interneti (Iot), siber-fiziksel sistemler (CPS) teknolojileri başta olmak üzere, sensörler ve büyük veri gibi dijital araçların atık izleme kaynak verimliliği gibi çevresel etkileri azaltarak döngüsel ekonomiye katkı sağladığını ancak bu teknolojilerin uygulanmasında enerji tüketimindeki artış, yüksek maliyetler ve veri güvenliği ile ilgili endişelerin bu teknolojilerin benimsenmesinde karşılaşılan başlıca zorluklar olduğu belirtilmiştir (Nara ve diğ., 2021).

Dijital teknolojilerin döngüsel ekonomi üzerindeki etkilerine dair diğer önemli çalışmalar ise BIM, nesnelerin interneti (IoT), büyük veri ve siber-fiziksel üretim sistemlerinin inşaat projelerinde kaynak verimliliği ve atık azaltımı konularında sağladığı katkılara odaklanmaktadır. Ghobakhloo (2020), bu teknolojilerin entegrasyonunda yüksek maliyetler ve siber güvenlik risklerinin özellikle küçük ve orta ölçekli firmalar için önemli engeller oluşturabileceğine dikkat çekmiştir (Ghobakhloo, 2020). Hao ve diğ., (2020), prefabrikasyon inşaat uygulamalarında BIM'in karbon emisyonlarını azaltma konusundaki etkilerini vurgulamış ve bu teknolojinin döngüsel ekonomi hedeflerine katkıda bulunabileceğini göstermiştir. Ayrıca yazarlar, bu hedeflere tam olarak ulaşılabilmesi için hükümet politikalarının prefabrikasyon kullanımını teşvik etmesi gerektiğini göstermektedir (Hao ve diğ., 2020).

Dijital teknolojilerin inşaat projelerinde daha etkin bir şekilde kullanılabilmesi için sektörel stratejilerin geliştirilmesi gerektiği de literatürde ön plana çıktığı görülmektedir. Munaro & Tavares (2021), tarafından malzeme pasaportlarının daha geniş çapta benimsenmesi için dijital veri yönetim platformlarının geliştirilmesi gerektiği belirtilmiştir (Munaro & Tavares, 2021). Jemal ve diğ., (2023), dijital teknolojilerin kaynak verimliliğini artırma, atık azaltımı sağlama ve çevresel sürdürülebilirliği desteklemede inşaat sektörüne önemli katkılar sağladığını ortaya koymuşlardır (Jemal ve diğ., 2023). Banihashemi ve diğ., (2023), BIM, dijital ikizler ve malzeme pasaportları gibi dijital teknolojilerin döngüsel ekonomi modeline katkı sağlama potansiyelini incelemiş, ancak bazı engellerin de var olduğunu vurgulamıştır (Banihashemi ve diğ., 2023). Charef (2024), dijitalleşmenin döngüsel ekonomi üzerindeki etkilerini değerlendirerek, dijital teknolojilerin proje yaşam döngüsünün her aşamasında veri toplama ve analiz süreçlerini desteklediğini ifade etmiştir (Charef, 2024). Zandee ve diğ. (2022) tarafından yapılan çalışmada ise dijital teknolojilerin döngüsel ekonomi modeline entegrasyonunda stratejik yaklaşımlar geliştirilmesi gerektiğini vurgulamaktadır (Zandee ve diğ., 2022). Munaro & Tavares (2021), malzeme pasaportlarının daha yaygın kullanılması ve dijital veri yönetim platformlarının geliştirilmesi gerektiğini belirtmektedir (Munaro & Tavares, 2021). Bu bağlamda, dijital teknolojilerin döngüsel ekonomi ilkeleriyle entegre edilmesi sürecinde yasal düzenlemeler, teşvik mekanizmaları ve organizasyonel süreçlerin yeniden yapılandırılması gibi konular büyük önem taşımaktadır (Banihashemi ve diğ., 2023; Meng ve diğ., 2023). Öte yandan dijital teknolojilerin döngüsel ekonomiye entegrasyonu, hem sürdürülebilirlik hem de ekonomik verimlilik açısından büyük bir potansiyele sahip olmasına rağmen, bu potansiyelin tam olarak gerçekleştirilmesi için gerekli altyapının oluşturulması, yasal düzenlemelerin hayata geçirilmesi ve tüm paydaşlar arasında güçlü bir işbirliği mekanizmasının kurulması gerekmektedir (Talla & McIlwaine, 2024). Bu süreç, dijital teknolojilerin sunduğu avantajların en üst düzeyde kullanılmasını sağlayarak, döngüsel ekonomi hedeflerine ulaşılmasına

önemli katkıları sunacaktır. Bu bölümde bahsedilen çalışmaların özeti Tablo 1’de gösterilmiştir. Çalışma kapsamında incelenen veriler doğrultusunda dijital teknolojilerin döngüsel ekonomi uygulamalarında sunduğu fırsatların yanı sıra, bu teknolojilerin etkin kullanılabilmesi için aşılması gereken zorlukları da ortaya koymaktadır.

SONUÇ ve ÖNERİLER

Bu çalışmada dijital dönüşümün inşaat sektöründe döngüsel ekonomi ilkelerinin uygulanması üzerine değerlendirilen araştırmalar, gelecekte yapılacak araştırmalara ışık tutması amacıyla incelenmiştir. Literatürde dijitalleşme ve döngüsel ekonomi entegrasyonu üzerine yapılan araştırmalarının artmasının bu iki kavramın inşaat sektörü bağlamında nasıl daha etkin uygulanabileceği, karşılaşılan engellerin nasıl aşılabileceğinin daha iyi anlaşılabilmesine sebep olarak kurumsal, sektörel, çevresel ve ekonomik gelişmelere yol açması beklenmektedir.

Dijitalleşme ve döngüsel ekonomi entegrasyonuna yönelik son beş yılı kapsayan çalışmalar sonucunda kaynak verimliliği, atık azaltımı ve çevresel sürdürülebilirlik gibi konularda fayda sağlandığı gözlemlenmiştir. Bu bakımdan BIM, nesnelerin interneti (IoT), büyük veri, dijital ikizler ve malzeme pasaportları gibi dijital araçlar, inşaat projelerinin çevresel etkilerini minimize etme ve kaynakların daha verimli kullanımını teşvik etme potansiyeline sahip olduğu düşünülmektedir. Ancak, bu teknolojilerin tam potansiyellerinin gerçekleştirilebilmesi için sektörde çeşitli zorluklarla karşılaşıldığı görülmüştür. Özellikle küçük ve orta ölçekli firmalar açısından veri güvenliği ve gizliliği konusundaki endişeler, yüksek maliyetler, yasal düzenlemelerin eksikliği ve sektördeki paydaşlar arasında yeterli işbirliğinin sağlanamaması, dijital dönüşüm sürecini zorlaştıran temel engeller olarak ön plana çıkmaktadır. Dolayısıyla, küçük ve orta ölçekli işletmelerin dijital dönüşüm sürecinde daha hassas bir yaklaşıma ihtiyaç duyduğu ortaya çıkmıştır. Bu firmaların sahip oldukları sınırlı kaynakları nedeniyle yüksek maliyetli dijital teknolojilerin benimsenmelerinde büyük zorluklar yaşanmakta ve bu durum dijital dönüşümün faydalarından tam olarak faydalanmalarını zora soktuğu sonucu ortaya çıkmıştır. Bu bakımdan küçük ve orta ölçekli firmaların bu dönüşüme katılımını teşvik etmek ve desteklemek için özel finansal ve teknik yardım programlarının oluşturulması gerekmektedir.

Sonuç olarak, dijital teknolojilerin döngüsel ekonomi ilkeleriyle entegre edilmesi, inşaat sektöründe çevresel sürdürülebilirlik hedeflerine ulaşılmasına önemli katkıları sunabilecek bir potansiyele sahip olduğu sonucu çıkarılmaktadır. Ancak bu potansiyelin tam olarak hayata geçirilebilmesi için, sektörel stratejilerin geliştirilmesi, yasal düzenlemelerin iyileştirilmesi ve dijital teknolojilerin benimsenmesini teşvik eden politikaların oluşturulması gerekmektedir. Özellikle küçük ve orta ölçekli firmalar için, dijital dönüşümün daha sürdürülebilir hale getirilmesi, sektör genelinde bu teknolojilerin kullanımının yaygınlaştırılmasını sağlayacaktır. Bu bağlamda, gelecekteki araştırmaların, dijital dönüşümün döngüsel ekonomi üzerindeki uzun vadeli etkilerini incelemeye ve bu süreci kolaylaştıracak yenilikçi çözümler geliştirmeye odaklanması önerilmektedir.

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DEVELOPMENT OF SUPPORTED CATALYST FOR HYDROGEN FUEL TECHNOLOGY FROM TEA PULP

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Abstract

Tea is one of the most consumed agricultural plants in the world. The tea plant, which is consumed in different forms, is generally consumed by extraction. In this process, the extract between 1-2% of the total mass of the tea passes into the water, while the remaining pulp is left to the environment as waste.

In this study, it was aimed to synthesize a supported catalyst to be used in hydrogen fuel technology from tea extract by classical method. For this purpose, tea pulp was taken from different enterprises, dried and weighed. Within the scope of the study, extract was produced from tea waste by classical method. After the produced extract was interacted with Co metal atoms, supported catalyst synthesis was achieved by co-precipitation method. Catalyst activity was tested by NaBH₄ (SBH) hydrolysis. The hydrogen production parameters of the tea extract supported cobalt catalyst (Co@extract-tea), which was found to show high catalytic activity, were investigated.

The parameters examined for hydrogen production are; support loading amount, solution medium, catalyst amount, SBH concentration, temperature and repeated use parameters. The best production parameters were determined as 90% support loading, 5% NaOH concentration by mass, 50 mg catalyst usage, 5% NaBH₄. As a result of catalytic hydrolysis reactions with optimum parameters, hydrogen production rate was determined as 8037 mL/g.min. As a result of the reaction kinetics investigations, it was determined that the reaction was of the 0th order and the reaction activation energy (E_a) was 32.53 kJ/mol.

The Co@extract-tea supported catalyst obtained from tea pulp extract shows much higher catalytic activity than many support materials used in the related field, which is considered as a seminal development.

Keywords: Tea pulp, Supported catalyst, Hydrogen

INTRODUCTION

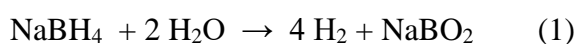
Energy is one of the most basic requirements for the continuation of human life. Energy, which is an indispensable power source for domestic or industrial use, is produced from various sources. Coal, natural gas, oil, sun, wind, etc. The production of energy, which can be produced from many sources, from alternative renewable energy sources has increased in recent years. However, this increase is not at the level it should be. Due to various limitations in renewable and environmentally

friendly energy sources, energy production is still mostly fossil-based today (Barreto, 2018; Abas et al., 2015).

In the conversion of fossil fuels into energy, carbon dioxide (CO₂) and some other harmful end products are released into the environment. CO₂ and some other gases cause the infrared rays coming from the sun to the Earth to be more retained in the atmosphere. This results in an increase in the average temperature of the Earth. This situation, called global warming, causes negative problems on the living structure and the environment, especially climate change. These problems adversely affect all living things in the world, especially human health (Lotfalipour et al., 2010; Gurney et al., 2009; Archer, 2005)

In order to limit the use of fossil fuels and save the world from increasing global warming, renewable energy sources such as solar, wind, geothermal, hydroelectric, tidal, and hydrogen energy should be used. However, renewable energy sources other than hydrogen have various limitations. Hydrogen has the potential to be the energy source of the future compared to other energy sources. Because there are no limitations when we want to convert hydrogen into energy (Lamichaney et al., 2020).

Despite such advantages, hydrogen faces the problem of transportation and storage because it is a high-volume gas. This problem is eliminated by chemically storing hydrogen in boron compounds. This is a great advantage for our country. Because our country is the richest country in the world in terms of boron minerals. The recovery of hydrogen stored in boron compounds is through catalytic systems. Sodium borohydride is the leading boron compound in which hydrogen is stored. During the dehydrogenation of hydrogen stored in sodium borohydride compound, hydrogen as much as the compound structure is obtained from the solvent as shown in Equation 1. Another important advantage of this reaction is that hydrogen production is catalyst controlled. (Kojima et al., 2002; Muir and Yao 2011, Şahin et al., 2016; Onat, 2016).



Arrhenius (2) equation is one of the most important parameters examined in the catalytic process. Activation energy, which is one of the important parameters of reaction kinetics, is calculated by utilizing this equation.

$$k = Ae^{-Ea/RT} \quad (2)$$

The most important element of catalytic processes is the catalyst. When catalyzed applications are examined, it will be seen that there are applications in many fields. Supported catalyst technology, which has been used in recent years due to the advantages of catalyzed systems, continues to develop rapidly. The most basic feature sought in the supported catalyst structure is the high surface area provided by the support material to the catalyst (Hagen, 2015; Taştaban, 2019; Li et al., 2022).

The main features sought in the support material used in catalysts are that the material should be an inert, porous material, have a stable structure of components and be a material that allows surface width (Hagen, 2015). Graphene oxide, which has more than the mentioned properties, is one of the structures used as support material (Iris et al., 2019).

Plant extracts are organic structures with different properties that have been investigated by researchers for many years. When the studies in this field are examined, it will be seen that the studies are mainly focused on biological activity. Plant extracts with very rich phenolic material content whet the appetite of researchers. As the consumption network of plants used in the production of such extracts expands, they become more important (Dias et al., 2021; Albano and Miguel 2011; Rayne and Mazza 2007; Gramza et al., 2005). Another important issue is the recovery

of plant wastes with a wide range of uses. In studies carried out for this purpose, both the waste product is utilized and technological products with high added value are developed. Based on this basic idea, this study aims to investigate the use of tea pulp extract in catalytic hydrogen reactions.

DEVELOPMENT

This study is based on experimental data carried out in the laboratory. Within the scope of the study, firstly, tea extract extraction was studied. For this process, tea pulp was taken from different enterprises and dried. The dried pulp was extracted by classical method. This process consists of stirring the tea pulp in pure water at 250 rpm for 3 hours at 100 oC. As a result of the stirring process, the mixture was allowed to reach room temperature and filtration was performed. The extract was obtained from the filtrate by evaporation. After the production of the support material, the support material was loaded with metal by impregnation method. The loading process was carried out by mixing the support material and metal with a magnetic stirrer for 24 hours at room conditions (White et al., 2009). After the loading process, catalyst synthesis was achieved by reduction. The synthesized catalyst structures were dried in nitrogen atmosphere after filtration and washing. The dried catalyst structures were crumbled and used in hydrolysis reactions. The hydrolysis step, which constitutes the most intensive part of the study, is given in Figure 1. While the circulating water bath seen in the figure adjusts the ambient temperature, the jacketed tube forms the environment where hydrolysis takes place. The magnetic stirrer is involved in the realization of hydrolysis at a certain value. The gas burette is used to record the gas released over time.

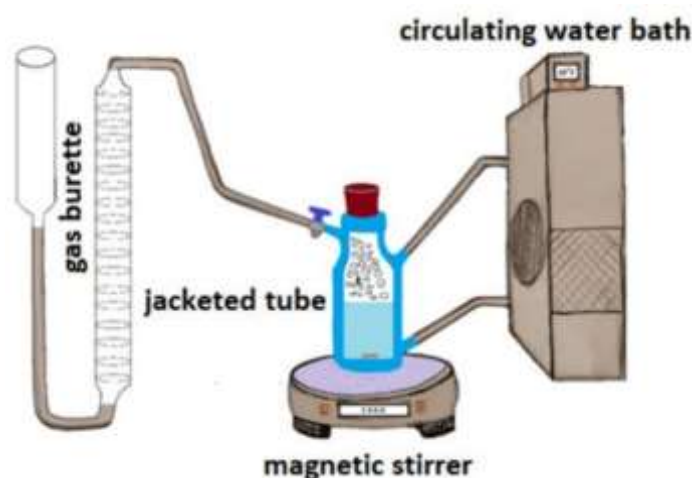


Figure 1. Hydrolysis experimental setup

The data obtained after the hydrolysis processes were processed on the computer and interpreted. In the last stage of the study, all the applications were reported.

The first support material parameter measured in supported catalyst studies in hydrogen production is the amount of support. In this study, synthesis and hydrolysis were carried out for different extract support amounts. The data related to these hydrolyses are given in Table 1. SBH hydrolyses were examined as a result of the supported catalyst synthesized with 80-95% support amounts. As a result of SBH hydrolysis, it was determined that the best support amount was achieved when 90% extract was used. In the continuation of the study, catalytic hydrolysis reactions were carried out by synthesizing supported catalyst with the use of 90% extract (Ye et al., 2007).

Table 1. Hydrogen production data versus different tannin (support) amounts

Time (min)	% 95 Tannin - % 5 Co	% 90 Tannin -% 10 Co	% 85 Tannin -% 15 Co	% 80 Tannin -% 20 Co
0	0	0	0	0
0,08333333	7	10	6	8
0,16666667	18	22	15	15
0,25	26	38	25	22
0,33333333	42	56	45	26
0,5	54	78	65	45
0,75	75	110	95	62
1	104	140	120	80
1,5	153	172	145	95
2	190	204	170	112
2,5	230	263	210	148
3	260	324	250	186
3,5	288	380	293	222
4	315	438	334	264
5	362	500	372	302
6	410	554	455	370
7	450	606	536	438
8	490	654	616	492
9	530	680	678	548
10	562			604
11	592			652
12	622			678
13	650			
14	672			

For comparison, the hydrogen onset rate measured as a result of the catalytic hydrolysis reaction of pure $\text{Co}_{(0)}$ metal was 2785 mL/g.min. As can be seen from the hydrogen yields, the supported catalyst structure showed a high catalytic effect. After determining that the 90% supported catalyst structure was very effective for the best support amount for the tea extract, the hydrolysis reaction optimum data were examined.

The optimum data investigation was carried out at room temperature (298 K). The parameters examined for the optimum data are; solution medium, amount of catalyst, concentration of hydrogen source sodium borohydride, temperature and repeated use of the catalyst. NaOH concentration containing common ion was analyzed as the solution medium. As it is known, sodium borohydride (NaBH_4) decomposes spontaneously, albeit slightly. This degradation can be prevented at high pH. Hydrolysis data obtained as a result of catalytic hydrolysis degradation reactions at different NaOH concentrations (2.5%-10%) are given in Table 2. As seen in the table, the best catalytic degradation occurs at 7.5% NaOH concentration. In the continuation of the study, the investigation of catalytic degradation reactions was continued with a solution medium concentration of 7.5% NaOH (Wang et al., 2017).

Table 2. Hydrogen production data versus different NaOH concentrations

Time (min)	% 2.5 NaOH	% 5 NaOH	% 7.5 NaOH	% 10 NaOH
0	0	0	0	0
0,083333	8	10	10	6
0,166667	18	22	22	13
0,25	28	38	36	23
0,333333	46	56	50	36
0,5	63	78	75	48
0,75	94	110	106	72
1	118	140	136	104
1,25	146	172	170	140
1,5	172	204	202	170
2	226	263	260	226
2,5	272	324	324	288
3	318	380	388	345
3,5	370	438	450	412
4	420	500	518	470
4,5	475	554	582	532
5	532	606	638	588
5,5	586	654	672	638
6	640	680	680	676
6,5	680			

After determining the best concentration for the solution medium, hydrolysis reactions were carried out with different amounts of cobalt (Co) containing catalyst. The data obtained from the catalytic hydrolysis reactions carried out with different catalyst amounts of 20-50 mg are given in Table 3. When the table is examined, it is seen that the reaction rate increases with increasing catalyst amount. However, when the hydrogen yield per catalyst was calculated, it was determined that the best catalyst amount for Co@extract-tea catalyst was 40 mg. Therefore, the study was continued with 40 mg of catalyst as catalyst amount.

Table 3. Hydrogen production data versus different amounts of catalyst

Time (min)	20 mg	30 mg	40 mg	50 mg
0	0	0	0	0
0,083333	5	10	12	14
0,166667	14	22	30	36
0,25	21	36	45	52
0,333333	32	50	60	66
0,5	52	75	92	100
0,75	78	106	134	142
1	98	136	180	192
1,25	120	170	230	245
1,5	142	202	276	295
2	182	260	368	396
2,5	225	324	460	505
3	270	388	560	610
3,5	312	450	646	680
4	357	518	680	
4,5	400	582		
5	444	638		
5,5	485	672		
6	532	680		
6,5	578			
7	618			
7,5	664			
8	680			

After determining the best use of Co as catalyst amount, catalytic hydrolysis reactions were carried out with different concentrations of sodium borohydride used as hydrogen source. Catalytic hydrolysis data with different SBH concentrations are given in Table 4. When the table is examined, it is seen that there is an increase in the hydrogen onset rate in response to increasing NaBH₄ concentration. It is seen that the increase in hydrogen onset rate starts to decrease after the use of 5% NaBH₄. This can be interpreted as an increase in the substrate density per catalyst (Onat, 2016). The optimum conditions were 303 K, 7.5% NaOH concentration, 40 mg catalyst amount and 5% SBH concentration. The hydrogen onset rate measured at these optimum conditions is 8037 mL/g.min. This value is quite high for Co metal catalyzed sodium borohydride (Zhu et al., 2013).

Table 4. Hydrogen production data versus different NaBH₄ concentrations

Time (min)	% 2.5 NaBH ₄	% 5 NaBH ₄	% 7.5 NaBH ₄	% 10 NaBH ₄
0	0	0	0	0
0,083333	12	12	12	14
0,166667	30	23	28	30
0,25	45	46	42	40
0,333333	60	63	58	60
0,5	92	90	85	82
0,75	134	140	120	125
1	180	185	162	165
1,25	230	220	196	210
1,5	276	260	235	250
2	368	330	306	330
2,5	460	396	368	415
3	560	455	430	485
3,5	646	506	480	550
4	680	565	526	610
4,5		620	582	660
5		678	620	705
5,5		740	675	750
6		800	730	800
7		920	824	880
8		1035	916	970
9		1150	1005	1065
10		1250	1095	1142
11		1345	1170	1215
12		1365	1254	1295
13			1340	1375
14			1425	1445
15			1510	1520
16			1595	1600
17			1675	1680
18			1760	1760
19			1852	1830
20			1930	1910
21			2000	1990
22				2070
23				2150
24				2220
25				2294
26				2365
27				2432
28				2504
29				2580
30				2655
31				2710

After determining the optimum data for the catalytic hydrolysis reaction, catalytic hydrolysis reactions were carried out at 30, 40, 50 and 60 °C for reaction kinetics investigations and observation of product formation at different temperatures. Catalytic hydrolysis reaction data at different temperatures are given in Table 5. When the table is examined, it will be seen that there is an increase

in hydrogen initial rates parallel to the increase in temperature. This means that the number of effective collisions increases with the increasing kinetic energy of the particles parallel to the temperature increase. In other words, it can be said that the number of particles exceeding the activation energy increases parallel to the temperature increase.

Table 5. Hydrogen production data versus different hydrolysis temperatures

Time (min)	30 ° C	40 ° C	50 ° C	60 ° C
0	0	0	0	0
0,083333	12	15	16	20
0,166667	30	36	56	70
0,25	45	56	80	102
0,333333	60	75	105	132
0,5	92	115	150	190
0,75	134	165	215	269
1	180	220	276	348
1,25	230	272	336	420
1,5	276	325	392	495
2	368	421	505	630
2,5	460	522	620	680
3	560	620	680	
3,5	646	680		
4	680			

The concentration change data of the catalytic reactions carried out at different temperatures were correlated with different reaction degrees (0th, 1st and nth order) for the reaction given in Equation 1. As a result of the association processes, it was determined that the sodium borohydride hydrolysis reaction catalyzed by the Co@extract-tea catalyst fits the 0th order reaction equation. When the slope of the graph equation obtained by plotting $\ln(k)$ versus $1/T$ from the 0th order reaction data is utilized and the data are substituted in the Arrhenius equation given in Equation 2, the activation energy (E_a) of the catalytic reaction is found as 32.53 kJ/mol. The activation equation data obtained from the related equation data are given in Figure 2.

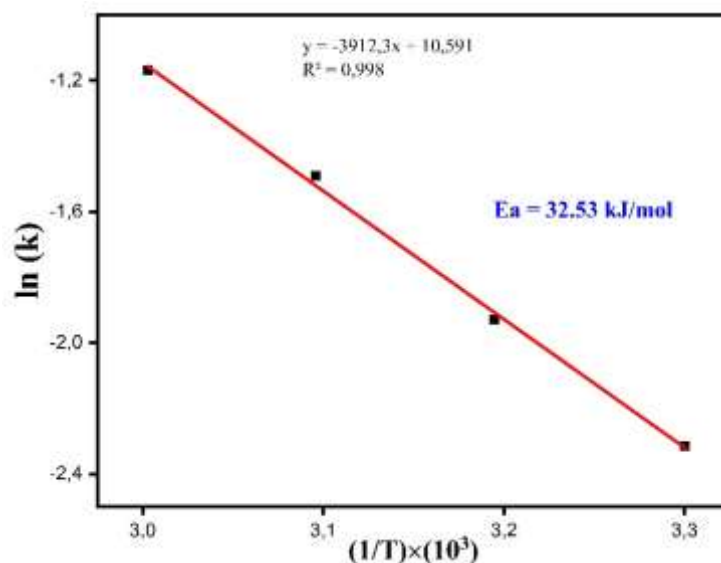


Figure 2. Arrhenius equation 0. degree data

One of the important parameters of the catalytic reaction is the repeated use of the catalyst. In this study, the repeated use of sodium borohydride hydrolysis was investigated for the synthesized Co@extract-tea catalyst. In repeated use applications, after the hydrolysis processes, 90% of the liquid part of the solution was taken into another container by decantation and new hydrogen source was added after waiting for the catalyst structure to precipitate well. In this way, six consecutive uses of the catalyst were repeated. Hydrolysis data for repeated uses are given in Table 6. When the table is examined, it can be seen that even at the end of the 6th use, 100% efficiency was achieved. This means that the efficiency of the catalyst is resistant to repeated use. The slight decrease in performance in parallel with repeated use indicates that the metaborate structure formed covers the active surface of the catalyst and partial deformations occur.

Table 6. Hydrogen production data versus catalyst reuse

Time (min)	1. Use	2. Use	3. Use	4. Use	5. Use	6. Use
0	0	0	0	0	0	0
0,083333	12	13	10	8	6	7
0,166667	30	26	21	17	14	13
0,25	45	38	32	26	20	21
0,333333	60	47	40	36	32	28
0,5	92	70	62	52	40	38
0,75	134	95	82	70	58	57
1	180	123	104	90	80	76
1,25	230	146	125	112	102	98
1,5	276	170	142	128	118	114
2	368	215	182	165	152	146
2,5	460	262	222	203	187	178
3	560	305	265	240	220	215
3,5	646	350	302	276	256	250
4	680	400	340	310	292	280
4,5		442	375	345	320	310
5		485	416	382	360	343
5,5		530	452	418	394	384
6		578	492	454	427	400
7		660	565	528	496	456
8		680	642	600	565	514
9			680	658	620	568
10				680	660	624
11					680	666
12						680

CONCLUSION AND DISCUSSION

Within the scope of the study, catalytic reaction data of SBH hydrolysis were investigated by synthesizing supported catalyst from tea pulp extract. For this process, tea pulp was collected, dried and extracted respectively. The extract was used as catalyst support material for Co metal. Impregnation method was used for this process. The Co metal decorated on the support material by impregnation method was reduced under SBH by co-precipitation method. After necessary filtration and drying in nitrogen atmosphere, the SBH hydrolysis parameters of the crumbled supported catalyst were investigated.

Within the scope of the study, it was determined that the tea extract supported catalyst structure was more than 3 times higher than the hydrogen production amount provided by the catalyst structure formed by unsupported cobalt metal atoms. The fact that the supported catalyst provides a hydrogen starting rate around 3-4 times higher than the unsupported catalyst indicates that a catalyst structure with high catalytic efficiency has been synthesized. However, it is seen that the extract, which can be obtained at very low costs, provides very high catalytic effect compared to some support materials (Ingersoll et al., 2007; Özdemir, 2015; Sahiner and Sagbas, 2014). However, other materials used as support materials (Zhu et al., 2013; Shi et al., 2019) can be obtained either at high cost or as a result of long processes. This means that tea extract used as a support material turns into a high value-added product.

As a result of the optimization of the catalytic hydrolysis reaction examined within the scope of the study, the best solution medium was determined as 7.5% NaOH, 40 mg for the best catalyst amount, and 5% SBH by mass as the best SBH concentration in the reactions carried out at 303 K. The best hydrogen onset rate measured at these values was 8037 mL/g.min. As a result of the reaction kinetics investigations, it was determined that the reaction was of the 0th order and the activation energy was 32.53 kJ/mol.

In this study, the catalytic hydrolysis effect of tea extract Co combination for hydrogen production was measured. In similar catalytic processes, a broader effect measurement can be achieved by studying the supported material of tea extract. Based on the results of the study, it can be said that the tea extract supported catalyst can be used in hydrogen production, which is an alternative renewable energy to fossil fuels.

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FOOD-ENERGY-WATER NEXUS BASED ANALYSIS OF THE AGRICULTURAL CROP PATTERN OPTIMIZATION

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Abstract

Introduction and Purpose: Agriculture is a major consumer of freshwater resources, accounting for roughly 70% of total usage. Energy is also vital at various points throughout the agricultural and food production processes. This highlights the complex interconnections among food, energy, and water resources. This study explores alternative cropping pattern scenarios generated through optimization methods and examines them holistically within the framework of the food-energy-water nexus.

Materials and Methods: In this study, a linear programming model is employed to determine the optimal cropping pattern with the goal of minimizing water usage in agriculture. In linear programming, the applied constraints include maintaining agricultural income nearly constant, preserving the total cultivated area, and limiting the range of changes in the cultivated area to a maximum of 5%. Crop patterns for the periods 2017, 2025-2050, 2050-2075, and 2075-2100 were established using linear programming. For each timeframe, calculations were made for water consumption, energy needs, agricultural revenue, and carbon dioxide emissions, incorporating the food-energy-water nexus approach. The scenarios were compared to assess their outcomes.

Results: All the scenarios analyzed achieved reductions in water consumption, energy demands, and carbon dioxide emissions. Across all evaluated time periods, scenario 6, which allows 5% change in cultivated areas without a limit on the total cultivated area, emerged as the best option. This scenario resulted in an average decrease of 3.94% in water usage, 2.95% in energy requirements, and 1.62% in carbon dioxide emissions relative to the base scenario.

Discussion and Conclusion: The results demonstrate that altering crop patterns can lead to substantial decreases in water consumption, energy use, and carbon dioxide emissions, all while keeping agricultural revenue relatively stable. It was observed that including a constraint requiring the total cultivation area to be at least as large as that in the base scenario limited the extent of these reductions.

Key Words: Cropping Pattern; Linear Programming; Optimization; Food Energy Water Nexus

INFLUENCE OF ECOLOGY ON EDUCATION AND HEALTH OF STUDENTS

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Abstract

The term "Ecology", a Greek word, originated in the 19th century and although it used to cover nature and natural sciences, it was later codified and dealt with problems in various areas of society and science and has become an integral part of human life today.

The term "ecology" is now defined as the subject of many socio-philosophical fields, law, medicine, science, including education and health care.

At the same time, the Greek word "Medicine" means "appropriate measures" and its purpose is to achieve human health.

Therefore, ecology and medicine are related to human life. Although ecology and medicine are two separate fields of science, their connection with human life is great.

This article discusses the impact of social, environmental medicine and environmental problems on human health and social life.

Since environmental medicine is the most important field of our time, the author analyzes the impact of global environmental disasters occurring in the world and regions on higher education, which is the core of society, the problems of the dependence of young people's life and health on the environment and climate, and tries to evaluate it based on scientific and experimental facts.

Key words: human, environmental medicine, education, ecology, health, disease

Introduction

In every country, Ecological problems have positive and negative effects on the medical and healthcare system, as well as on the lifestyle and education of young people, the most basic living area of society.

It is worth noting that Carolyn E., a member of the Science & Environmental Health Network (SEHN) since 1994, an environmental lawyer, expert, accumulated a wealth of niche experience and knowledge, and rose to the position of executive director of SEHN. In 2001, Raffensperger coined the term "Ecological medicine" and put forward the validity of the connection between medicine and ecology.

"Ecological medicine," coined by Carolyn Raffensperger, is a term coined for a new field of study and practice to reconcile the care and health of ecosystems, populations, communities, and individuals (3).

Carolyn Raffensperger believed that "The health of Earth's ecosystem is the foundation of all health. Human impact in the form of population pressure, resource abuse, economic self-interest, and inappropriate technologies is rapidly degrading the environment. This impact, in turn, is creating

new patterns of human and ecosystem poverty and disease. The tension among ecosystem health, public health, and individual health is reaching a breaking point at the beginning of the Twenty-First Century” (3)

As confirmed by research in the field of ecological medicine "Healing disciplines and movements of public health, ecology, conventional medicine, complementary and alternative medicines, conservation medicine, conservation biology, and campaigns such as Health Care Without Harm have sought to address this cycle of conflict among individual health, public health, and ecosystem health in different ways. Ecological Medicine honors these contributions and builds upon them. Ecological Medicine invites the biomedical community, ecologists, scientists, activists, and individuals who are concerned for personal health as well as the health of communities and future generations to learn from each other and to embrace a balanced, ecological approach to sustaining health"(3)

In addition, studies in the field of "Ecological Medicine" suggest the following scientific conclusion: “Public health measures, education, and medical advances have significantly reduced death and disease in many parts of the world, but some advances come at considerable cost, and the benefits are not equally distributed. Public health systems charged with creating healthful conditions for all have suffered in competition with technologically intensive health care aimed at individual consumers. Health care systems struggle to keep up with the changing patterns of disease that result both from a rapidly changing and degraded Earth and from the way people live. New and old diseases spread with increasing speed within and across national borders. Meanwhile, industrially based medicines and technologies that heal also contribute to the growing burden of environmental toxins in people, air, water, fish, animals, and plants(4).

Of course, the past 25 years have further substantiated the relationship between ecology and medicine, and as a result, it is appropriate to solve the many ecological problems faced by the human masses and nature in the modern era with the possibilities of the two sciences.

For example, Ted Schettler, SEHN's science director and an authority on environmental links to reproductive and developmental disorders, neurotoxicity, and other public health issues, published *Generations at Risk: Reproductive Health and the Environment* (MIT Press, 1999) and *In Harm: Toxic Threats to Child Development*”. (“Greater Boston Physicians for Social Responsibility”, 2000)" comments on scientists' research and suspicions about environmental causes. According to him, environmental problems "lead to disorders from learning disabilities to cancer." It also describes the great uncertainties and limits of science in establishing the relationship between cause and effect(3).

Therefore, there is also a field of ecological medicine in the world medical science, and this field is relevant in every period, especially in the time of climate change, which is one of the most serious environmental problems in our modern years.

As the researchers noted, "The importance of ecological education and ecological culture for humanity has become invaluable in modern conditions where ecological problems and their importance are increasing. "Humanity's relationship with nature is regulated by relevant laws, and this situation will sooner or later lead to environmental disasters" (2).

Therefore, the topic "Effect of ecology on the education and health of students" is important from a scientific and practical point of view.

Main part

It is known that the influence of ecology on human health is extremely great. Therefore, the immediate cause of all diseases is the ecological environment: Water, air, pollution, climate change, poor sanitation and lack of hygiene rules cause various diseases in people.

The world medical experience covers human health problems such as gastrointestinal, infectious, cardiovascular, broncho-obstructive, oncological, neurological pathologies, etc. confirms that ecology is responsible for common diseases.

One of the most serious reasons for the negative impact of the environment on human life and health is the lack of oxygen in parks. This can be explained by the construction of high-rise residential buildings, the demolition of parks, the creation of various commercial and residential facilities, and the use of vehicles, especially gas-powered cars, instead of the expansion of greenery. This situation limits air cleanliness by increasing the number of polluted areas while consuming the oxygen that humans get from the environment, and on the other hand, it causes air poisoning from factories that produce chemical waste. This type of waste poses a risk to human health and causes many diseases.

It is no coincidence that the poisoning of air, which is the most important component of human life, leads to the poisoning of essential food products, which are the cause of these diseases, and as a result, human death is inevitable, regardless of age.

Considering the heavy workload and many problems of living conditions of people on a large scale, including students, especially the youth groups who come to the city to study and rent houses, and therefore do not have a rational diet the concept "Effect of ecology on the education and health of students" once again confirms its relevance and scientific importance.

Of course, the health of this student population is at risk, especially due to environmental disasters, and the diseases they develop are often caused by heavy study loads, constant exams, financial pressures, and eventually become chronic including melting and even death.

This problem is of a more global nature, as it concerns the young people who are educated in the context of ongoing wars in a particular country.

Therefore, it is not difficult to imagine the lives of students whose homes, universities, dormitories, clinics, hospitals, and pharmacies were bombed.

Many masses of people, who are the pillars of the world's sustainable development, are still forced to leave their homelands, such as students, the elderly, children, women, babies, with many health problems (basic hygiene rules are not followed), socio-political problems and, most importantly, environmental disasters. prone to various diseases. The result is the interrelated destruction of nature and human health.

In support of this idea, we can cite the events that left a mark in the world press, such as the illegal sending of many refugees to foreign countries by boats, accidents, and living in ecologically unsuitable conditions for months. Of course, these people can be saved from a tragic situation thanks to humanitarian organizations and people who come to help. Not only the student population, no one is immune to the diseases caused by environmental disasters and politically motivated wars. At the same time, the world's elderly, children, women, infants, and students remain on the margins of education and sustainable development.

At present, environmental problems, which have become a global phenomenon, and avoidance of environmental safety requirements are leading humanity to destruction. As proof of this, the

European Regional Office of the World Health Organization adopted the "Healthy environment, healthy people" program, which stands out as one of the positive problems of our time.

"A healthy environment means healthy people." "During the last 20 years, WHO's European Center for Environment and Health has become one of the world's leading centers of expertise in this field. The Center is committed to meeting the highest standards of scientific integrity and ethics in its work in gathering and analyzing evidence and developing regulations and guidelines on environmental and health issues as health becomes more relevant and recognized both globally and politically. In the European context. Thus, the 2030 Agenda for Sustainable Development, which is the final result of sustainable development together with environmental factors of health and well-being and human labor activity, gives a new impetus to the work of the Center, is a defining and positive system. factors" (6).

The result

Thus, while studying the topic "Effect of Medical Ecology on the Education and Health of Students", we analyzed ecology and health together with the same goal, although the phenomena of education, ecology and health have different meanings. In this direction, the principles of the field of ecological medicine are the basis for the whole of humanity, the students who make up its most important group. It is no coincidence that the field of Environmental Medicine **Interdependence** (Individuals cannot live healthy and happy lives in poisoned ecosystems and unhealthy communities. Likewise, healthy communities and biological systems depend on human control and responsibility in technology, population, production and consumption), **Resilience** (Both medicine and ecosystem science and management must focus on promoting and restoring the innate ability of biological systems to protect, restore, and heal themselves.) incorporates the following concepts and values), **Compatibility** ("Medicine" is from the Greek "appropriate measures" means. The goal is to achieve maximum health with minimal intervention by promoting good health appropriate to the individual's life stage without overloading the Earth's life-sustaining processes), **Diversity** (Different approaches to health, including many traditional healing systems, local adaptations and all local science serves the world), **Collaboration** (Patients must collaborate with practitioners, and health care professionals with ecologists and other students of the natural world to gain knowledge and improve practices), **Reconciliation** (Societies must build and maintain infrastructures that enable all citizens to meet their basic needs, such as health, nutrition, family planning, shelter, and meaningful work) and the provisions we have outlined include brief examples(3).

The principles of Cooperation and Reconciliation of Ecological Medicine are directly related to students and young people, who are the main part of human society, and in our opinion, there is a great need for important challenges in this field(3).

In our opinion, in the context of "Effect of ecology on the education and health of students", it is necessary to create a large number of ecological medicine clinics that benefit the safety and sustainable development of society and humanity, increase the number of pharmacies, prepare social projects, as well as implement important programs, along with the large-scale production of medical drugs and paraphernalia)(3).

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POTENTIAL "SOLUTION IMPACT" OF GREEN ERGONOMICS ON SUSTAINABLE ENVIRONMENTAL PROBLEMS THAT THREATEN HUMAN LIFE

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Abstract

The world is becoming increasingly arid and this is having serious negative impacts on ecosystems. In the last 20 years, drought events have increased by 29%. This increase reduces the productivity of agricultural land and leads to a decrease in water resources. As concrete structures in cities move to villages, green areas are shrinking rapidly. In the last 30 years, green areas in cities have decreased by 40%. This weakens the connection of people living in cities with nature and negatively affects air quality. The degradation of ecosystems continues to the detriment of humans. Global biodiversity has declined by 68% due to human activities. This loss destabilizes ecosystems and puts many species at risk of extinction. In addition, the mismanagement of vacant and idle spaces leads to increased crime rates. The existence of such areas has increased crime rates by 15%. This threatens the security of communities and leads to social unrest. All these changes point to serious problems, both environmental and social. People's social space is shrinking and their quality of life is declining. Green ergonomics is an important approach that can offer solutions to these problems. Green ergonomics aims to create designs that prioritize nature and ensure human-machine-environment harmony. This approach includes practices such as protecting and increasing green spaces in cities, constructing energy efficient buildings and ecologically utilizing idle areas. Green ergonomics not only provides environmental benefits, but also promotes social peace by improving people's quality of life. Therefore, adopting green ergonomics principles is critical for a sustainable future. In this context, green ergonomics is the ergonomic view of human design that prioritizes nature. Green ergonomics is defined as ergonomics practices that aim to reduce the negative impact of designed products, jobs and systems on the environment.

Green ergonomics not only focuses on nature, but also considers social and economic capital. A balance needs to be achieved between the economic and social development needs of people and natural systems.

Thatcher stated that green ergonomics is primarily about the role of human systems in protecting, conserving and restoring natural capital. Ecosystems provide a variety of services such as food, water, minerals, water purification, waste decomposition, flood and drought risk reduction. With the degradation of the natural environment, it becomes difficult for these services to continue and it becomes impossible to talk about sustainable human well-being and effectiveness. Green ergonomics aims to prevent human-induced crises or mitigate the effects of natural crises and reduce the impact of human systems on ecosystem services through ergonomic design. It also explores how the human connection with nature can enhance human well-being and productivity. Green

ergonomics is grounded in psychological concepts and explores ways to incorporate the healing and creative properties of nature into the design of workplaces, homes and playgrounds.

Cities are responsible for 60% of greenhouse gas emissions worldwide. Insufficient or absent green spaces and increased concretization cause the urban heat island effect. Therefore, the temperature in cities is 3-5 °C higher than in rural areas.

Following this determination of the World Health Organization, to give an example of how green ergonomics can prevent air pollution; Mandavilli et al. determined that carbon dioxide, carbon monoxide, nitrogen oxide and hydrocarbon emissions decreased in single-lane roundabouts that replaced stop-controlled intersections in six cities in the states of Kansas and Nevada. Vehicles spent less time in the intersection and thus reached their destinations with less fuel consumption.

To illustrate the impact of green ergonomics on indirectly preventing crime, we can cite the following scientific study: A program in Philadelphia investigated the relationship between vacant spaces in low-income neighborhoods and stress and crime. In order to test its applicability in other cities, economical, scalable and sustainable interventions were chosen. The Task Force included experts from various fields such as criminal law, biostatistics, criminology, emergency medicine, psychiatry, forest service of the Ministry of Agriculture and epidemiology. As part of the intervention, garbage was collected, the area was landscaped, grass and trees were planted to create a park-like area, and a low wooden fence was installed around the perimeter. Crime records from the police station were compared with the results of a survey of 445 people living in these areas.

Participants' perceptions of crime, vandalism and security concerns when going outside their homes decreased, while the use of outdoor spaces for recreation and socializing increased.

The results of the study support another study which states that "vacant urban land affects people's perceptions of safety and physical security".

Significant reductions in crimes such as gun violence and theft are linked to interventions in vacant spaces in low-income neighborhoods.

This research has shown that the need for green space can be met by recycling unused areas. The results show that converting these areas into green spaces is a sustainable way to reduce crime rates in disadvantaged areas. This study not only added green space to the city, but also reduced the safety concerns of the residents. This multidisciplinary project can be associated with green ergonomics. This practice, which prioritizes human welfare, also contributes to the urban ecosystem.

Keywords: Green ergonomics, sustainable environment, ecology, nature, air pollution. security, peace, sustainable living, green world

CHRONIC LIVER FAILURE AND CIRRHOSIS - DIAGNOSIS, CAUSES AND CHARACTERISTICS

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Abstract

Liver cirrhosis (LC) is a worldwide health problem that is associated with various complications and high mortality. Although, in the past four decades, the incidence of hepatitis B continuously decreased and a promising cure for hepatitis C was developed, LC remains a formidable challenge in clinical practice due to the ever-increasing incidences of alcoholic and non-alcoholic fatty liver diseases, autoimmune-related liver disease and drug-induced liver disease.

Keywords: Liver failure, Cirrhosis, Diagnosis, Causes, Features

Liver cirrhosis (LC) is a worldwide health problem that is associated with various complications and high mortality. Although, in the past four decades, the incidence of hepatitis B continuously decreased and a promising cure for hepatitis C was developed, LC remains a formidable challenge in clinical practice due to the ever-increasing incidences of alcoholic and non-alcoholic fatty liver diseases, autoimmune-related liver disease and drug-induced liver disease (Kerimova R. C., Veliyeva Z. Y., Məşədiyeva Bayramova S. Ə. et al., 2022).

Most patients with cirrhosis remain asymptomatic until the onset of decompensation. When clinical signs, symptoms, or abnormal liver function tests are discovered, further evaluation should be pursued promptly. The most common causes of cirrhosis are viral hepatitis, alcoholic liver disease,

and nonalcoholic steatohepatitis. Initial workup includes viral hepatitis serologies, ferritin, transferrin saturation, and abdominal ultrasonography as well as complete blood count, liver function tests, and prothrombin time/international normalized ratio, if not already ordered. Additional testing is based on demographics and risk factors. Common serum and ultrasound-based screening tests to assess fibrosis include the aspartate transaminase to platelet ratio index score, Fibrosis 4 score, FibroTest/FibroSure, nonalcoholic fatty liver fibrosis score, standard ultrasonography, and transient elastography. Generally, noninvasive tests are most useful in identifying patients with no to minimal fibrosis or advanced fibrosis (Northup, P.G.; Garcia-Pagan, J.C., 2021). Chronic liver disease management includes directed counseling, laboratory testing, and ultrasound monitoring. Treatment goals are preventing cirrhosis, decompensation, and death. Varices are monitored with endoscopy and often require prophylaxis with nonselective beta blockers. Ascites treatment includes diuresis, salt restriction, and antibiotic prophylaxis for spontaneous bacterial peritonitis, when indicated. Hepatic encephalopathy is managed with lifestyle and nutritional modifications and, as needed, with lactulose and rifaximin. Hepatocellular carcinoma screening includes ultrasound screening every six months for patients with cirrhosis (Banini, B.A.; Alwatari, Y.; Stovall, M.; Ogden, N., 2020).

Activated Kupffer cells and monocytes initially induce inflammatory reactions in LC, after which the levels of TNF- α and other pro-inflammatory cytokines increase, and natural killer cells, natural killer T cells and macrophages are activated to aggravate systemic inflammation. Inflammatory evaluations have always been ignored when staging fibrosis, but the measurement of liver stiffness is emphasized. Instead, more attention should be focused on the focal inflammation of the liver parenchyma by liver biopsies and on systemic inflammation by the detection of serum or humoral inflammatory biomarkers. The control of the liver parenchyma and systemic inflammation has been observed to be able to slow the progression of decompensated LC or even reverse fibrosis to some extent (Northup, P.G.; Garcia-Pagan, J.C., 2021).

Cirrhosis usually develops from chronic hepatitis and transitions into compensated cirrhosis, after which there is a progression into decompensated cirrhosis. The early diagnosis of LC is difficult due to the absence of overt symptoms, the patient's neglect and a lack of appropriate biomarkers. Traditional liver biopsies have been widely accepted as the gold standard for the evaluation of liver fibrosis and liver parenchymal inflammation (Matei, D.; Craciun, R.; Crisan, D., 2021). Although liver biopsies are very safe with the use of ultrasonic guidance, these biopsies are still invasive procedures. Non-invasive serum fibrosis biomarkers are highly applicable and easily repeatable, and newly developed markers, including procollagen type III N-terminal peptide (PIIINP) and YKL-40, have been demonstrated to be of great value in detecting advanced fibrosis or cirrhosis with both a sensitivity and specificity of approximately 80%. However, none of the fibrotic markers is liver-specific; thus, these markers may be influenced by non-hepatic inflammation. On the other hand, numbers of composite score models combining multiple serum markers have been developed to accurately evaluate the degree of liver fibrosis. As two of the most validated models, the AST-platelet ratio index and fibrosis-4 (FIB-4) index have shown comparable results in excluding advanced, but not moderate, fibrosis (Yoo, J.J.; Kwon, J.H.; Kim, Y.S.; Nam, S.W., 2021).

Liver-specific markers and new score models are being exploited and show promise for more specific diagnoses in the near future. With regard to imaging methods for the diagnosis of liver fibrosis, routine ultrasound, computed tomography (CT) or magnetic resonance imaging (MRI) is not accurate enough for early diagnoses, whereas FibroScan and FibroTouch tests have certain reference values but are subject to inter-observer variation. Increasing amounts of data have shown that real-time shear wave elastography and magnetic resonance elastography are the most promising

and efficient evaluations for the early diagnosis of LC with respect to multi-sectional inspection, objectivity, sensitivity for early fibrosis and the ability to examine the entire liver. Recent studies have observed that the ultrasound measurements of the stiffnesses of the liver or spleen are promising tools for detecting clinically significant portal hypertension and for excluding severe portal hypertension, although these methods were limited by heterogeneous values and an inapplicability in hepatic decompensation (Kərimova R.C., Vəliyeva Z.Y., Həsənova X.Ə., et al., 2023).

Pathophysiology and natural history of cirrhosis: Chronic liver injury causes inflammation and hepatic fibrosis. Regardless of the cause, this can lead to the formation of fibrous septae and nodules, collapse of liver structures, and distortion of hepatic parenchyma and vascular architecture. Progressive fibrosis and cirrhosis subsequently result in decreased metabolic and synthetic hepatic function, causing a rise in bilirubin and decreased production of clotting factors and thrombopoietin, as well as splenic platelet sequestration, increased portal pressure, and the development of ascites and esophageal varices (Banini, B.A.; Alwatari, Y.; Stovall, M.; Ogden, N., 2020).

Cirrhosis can result from chronic liver damage of any cause. In patients with the three most common causes of liver disease, 10% to 20% will develop cirrhosis within 10 to 20 years. Factors associated with an increased risk of progression to cirrhosis include increased age, medical comorbidities (particularly patients coinfecting with HIV and HCV), and male sex (except in alcoholic liver disease, where females progress more rapidly). The point at which this process becomes irreversible, however, is not clear. Newer research has established that liver fibrosis is a dynamic process and that even early cirrhosis is reversible. Studies have demonstrated biopsy-proven fibrosis improvement rates as high as 88% after antiviral treatment in patients with HBV and HCV and as high as 85% after bariatric surgery in patients with nonalcoholic steatohepatitis (Panel, C.P.; Berzigotti, A.; Tsochatzis, E., 2021).

After cirrhosis is established, a patient may remain clinically stable, or compensated, for years. Patients with compensated cirrhosis caused by HBV, HCV, and alcoholic liver disease develop clinical signs of decompensation, which include ascites, hepatic encephalopathy, jaundice, or bleeding, at a rate of 4% to 10% per year. Variability of disease progression is influenced by the underlying cause and the presence or absence of treatment and ongoing liver injury. The median survival for those with compensated cirrhosis is 12 years, compared with two years once decompensation occurs (Kərimova R. C., Vəliyeva Z. Y., Məşədiyeva Bayramova S.Ə. et al., 2022).

Given that the liver is an organ with a dual blood supply from the portal vein and the hepatic artery, the maintenance of sufficient perfusion is significant for ensuring the nourishment of this organ. Injuries to the portal vein, which may occur as a result of devascularization surgery, a surgical portosystemic shunt, a splenectomy, an endoscopic tissue glue injection or radio-interventional therapy, should be carefully avoided to reduce the possibility of a portal vein thrombosis (PVT). PVTs have long been a difficult clinical problem. Although warfarin has been a traditionally efficient treatment, the dose titration highly relies on repeated INR tests and may result in poor patient compliance. New generations of oral anticoagulants, including rivaroxaban and dabigatran, have been proved to be effective, but they are also expensive. Failed cases that result from the use of anticoagulation therapy should consider the use of interventional portal vein recanalization techniques, including balloon angioplasty, stent-placement, thrombectomy and thrombolysis (Flamm, S.L.; Wong, F.; Ahn, J.; Kamath, P.S., 2022).

Gastric variceal bleeding: The prevalence of gastric varices in cirrhosis ranges from 6% to 20% and accounts for about 10% of all upper gastrointestinal bleeding in patients with portal

hypertension. Most of the current regimens to treat gastric varices are derived from anecdotal evidence or are extrapolated from trials of esophageal varices. Methods proposed to treat bleeding gastric varices include endoscopic sclerotherapy with conventional sclerosants, thrombin or butyl-cyanoacrylate, TIPS, and surgery. However, controlled trials are lacking, and once fundal gastric varices bleed, TIPS or surgery is advisable (Kerimova R.C., Veliyeva Z.Y., Hasonova X.Ə., et al., 2023).

Portal hypertensive gastropathy: In published studies, the prevalence of portal hypertensive gastropathy (PHG) varies between 7% and 98%. In the cirrhotic patient, the reported prevalence of acute bleeding from PHG is 4% to 38% of all acute bleeding. Rebleeding seems to be common, with a prevalence of 62% and 75%. Propranolol is the treatment of choice for both acute and chronic bleeding from PHG. If drug therapy fails, a portosystemic shunt (surgery or TIPS) aimed at decreasing the elevated portal pressure should be considered (Odriozola, A.; Puente, Á.; Cuadrado, A., 2022).

Ascites: Ascites is the most common of the major complications of cirrhosis, and approximately 50% of patients with compensated cirrhosis will develop ascites during 10 years of observation. Ascites results from renal retention of salt and water with localization of this excess fluid into the peritoneal cavity due to portal hypertension. Treatment of ascites is therefore aimed at creating a negative sodium and water balance and, if this strategy is inadequate, at decreasing portal pressure by portosystemic shunting (Karlsen, T.H.; Sheron, N.; Zelber-Sagi, S., 2022).

General measures: Bed rest is advisable for patients with a large amount of ascites because an upright posture is associated with activation of the renin-angiotensin-aldosterone system and the sympathetic nervous system, with consequent reduction of the glomerular filtration rate and of sodium excretion. Dietary sodium is restricted to 90 mEq/d or even 45 mEq/d if necessary. Fluids are restricted to 1500 mL/d; however, in the presence of dilutional hyponatremia (serum sodium level < 120 mEq/L), fluids are limited to less than 1000 mL/d (Yoo, J.J.; Kwon, J.H.; Kim, Y.S.; Nam, S.W., 2021).

Diuretic therapy: The choice of diuretic therapy depends on the urinary sodium levels. Patients with an initial urinary sodium level greater than 30 mEq/L can be managed with spironolactone alone; a combination of furosemide and spironolactone in a ratio of 40 mg and 100 mg is used if the urinary sodium level is 10-30 mEq/L. If the urinary sodium level is less than 10 mEq/L, large-volume paracentesis is needed in addition to diuretic therapy. Body weight and urinary sodium levels should be used to monitor therapeutic response. Target weight loss should be 1 kg/d in patients with peripheral edema and 0.5 kg/d in those without peripheral edema. Common complications of diuretic therapy include electrolyte imbalances (hyponatremia and hypokalemia-hyperkalemia), hepatic encephalopathy, renal impairment, gynecomastia, and muscle cramps (Yano, K.; Onishi, H.; Tsuboyama, T.; Nakamoto, A., 2022).

Large-volume paracentesis: Therapeutic paracentesis (large-volume or total abdominal paracentesis is indicated in patients with tense ascites. Therapeutic paracentesis with albumin infusion has been shown to have significantly lower complications (hyponatremia, renal impairment, and hepatic encephalopathy) compared with diuretic therapy. The preferred site of the paracentesis is the left lower quadrant, away from the rectus sheath to avoid injury to the inferior epigastric vessels (Karlsen, T.H.; Sheron, N.; Zelber-Sagi, S., 2022).

In addition, the sigmoid colon on the left side is more mobile and has a thicker wall than the cecum on the right side; thus, the risk of perforation is minimized if the paracentesis needle inadvertently

encounters the bowel wall. Concurrent plasma volume expansion with albumin (8 g/L of ascitic fluid removed) has been shown to be effective in preventing circulatory dysfunction after paracentesis and is currently recommended, as intravascular reequilibration occurs in 6 to 8 hours after ascitic fluid removal. Repeated therapeutic paracentesis may be necessary in a small number of patients whose condition is refractory to other forms of therapy.

Refractory ascites is defined as ascites that cannot be mobilized or early recurrence that cannot be prevented because of either a lack of response to salt restriction and diuretics (diuretic-resistant ascites) or the development of diuretic-induced complications (diuretic-intractable ascites). This condition is seen in about 10% to 20% of patients with ascites and available therapies include repeated large-volume paracentesis peritoneovenous shunts, and TIPS. However, peritoneovenous shunting is rarely used because of its attendant complications (shunt occlusion, infection and sepsis, vena caval thrombosis, and peritoneal fibrosis) and the introduction of alternative therapies such as paracentesis (Odriozola, A.; Puente, Á.; Cuadrado, A.,2022).

Although shown to be effective in patients with refractory ascites in conjunction with improved renal function, TIPS may result in deterioration of liver function and increased mortality compared with repeated paracentesis and albumin replacement and thus is recommended only in a study setting (Matei, D.; Craciun, R.; Crisan, D.,2021). The prognosis of patients with refractory ascites is extremely poor (1-year survival <50%), and liver transplantation should be considered (Flamm, S.L.; Wong, F.; Ahn, J.; Kamath, P.S.,2022).

Hepatorenal syndrome: The hepatorenal syndrome (HRS), a state of functional renal failure in patients with end-stage liver disease, is characterized by an increased creatinine level, relatively hyperosmolar urine, and a urinary sodium excretion of less than 10 mEq/L. The probability of occurrence of HRS in patients with cirrhosis is 18% at 1 year and 39% at 5 years. The prognosis for HRS is extremely poor, and the only proven treatment is liver transplantation (Yano, K.; Onishi, H.; Tsuboyama, T.; Nakamoto, A.,2022).

It is important to correct hypovolemia and to avoid use of all nephrotoxic agents (aminoglycoside antibiotics, nonsteroidal anti-inflammatory drugs, diuretics, and contrast agents) in cirrhotic patients with renal impairment. Arteriolar vasoconstrictors and TIPS have been used more recently without definite benefit (Panel, C.P.; Berzigotti, A.; Tsochatzis, E.,2021).

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SUSTAINABLE GROWTH: RECENT IMPROVEMENTS

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Abstract

Sustainable growth is an approach to economic development that emphasizes the preservation and enhancement of natural and social capital for future generations while achieving economic prosperity. This concept integrates economic, environmental, and social sustainability principles into development strategies, highlighting that long-term economic growth is unsustainable if it leads to environmental degradation or social inequity. By balancing these dimensions, sustainable growth aims to improve overall human well-being and maintain the health of ecosystems upon which economies and societies depend. The idea of sustainable growth has evolved through various economic theories and historical perspectives, with foundational models like Adam Smith's stadial theory of development illustrating the dynamic and often non-linear nature of societal progress. This approach encompasses diverse strategies, including the use of renewable energy sources, maintaining sustainable growth rates, and adopting theoretical frameworks that integrate different aspects of growth with sustainability principles. By implementing sustainable growth practices, policymakers and businesses can create a stable macroeconomic environment, protect property rights, and invest in public goods, addressing challenges such as climate change, resource depletion, and social inequality. Sustainable growth also involves adopting effective governance practices and integrating Environmental, Social, and Governance (ESG) principles into core strategies. This shift is driven by the increasing demand from consumers, investors, and regulators for greater transparency and accountability. Additionally, social protection and energy sector reforms play crucial roles in facilitating a just transition to a lower-carbon future. Large-scale transformations necessitate the reallocation of resources across organizations and the integration of climate and sustainability initiatives into ongoing efforts to enhance both business and sustainability performance. The measurement of sustainability involves various frameworks and indicators that span environmental, social, and economic domains. These measurements provide critical information for public policy-making and corporate sustainability reporting. The effective use of market-based instruments and careful design of subsidies can incentivize environmentally friendly practices while addressing market failures. The state's role in redistributive policies, economic valuation of ecosystem services, and participatory approaches in policymaking are essential for promoting sustainable development and ensuring that economic growth benefits all members of society equitably. This study aims to present the latest developments in the field of sustainability growth through a systematic literature review.

Key Words: Sustainable Growth, Sustainability, Economic Development

INTRODUCTION

Sustainable growth involves an economic development approach that prioritizes preserving and improving natural and social capital for future generations while also achieving economic prosperity. This concept merges economic, environmental, and social sustainability principles into development strategies, emphasizing that enduring economic growth is not viable if it results in environmental degradation or social inequity. Sustainable growth seeks to enhance overall human well-being and uphold the health of ecosystems that serve as the foundation for economies and societies by effectively balancing these dimensions.

The concept of sustainable growth has developed over time, drawing from a range of economic theories and historical viewpoints. Foundational models such as Adam Smith's stadial theory of development provide insight into the dynamic and sometimes non-linear nature of societal advancement. This approach encompasses a wide array of strategies, including the widespread utilization of renewable energy sources, the pursuit of sustainable growth rates, and the adoption of theoretical frameworks that holistically integrate various facets of growth with sustainability principles.

By implementing sustainable growth practices, policymakers and businesses can create an economic framework that promotes stability, protects property rights, and facilitates significant investments in public goods. This strategy enables effective addressing of critical challenges including climate change, natural resource depletion, and social inequality.

Sustainable growth requires the implementation of robust governance practices and the integration of Environmental, Social, and Governance (ESG) principles into core strategies. This shift is in response to increasing demand for transparency and accountability from consumers, investors, and regulators. Social protection and energy sector reforms are crucial in facilitating a just transition to a lower-carbon future. Large-scale transformations involve reallocating resources across organizations and integrating climate and sustainability initiatives into ongoing efforts to improve both business and sustainability performance.

Sustainability measurement encompasses a wide range of frameworks and indicators that cut across environmental, social, and economic dimensions. These measurements play a crucial role in informing public policy decisions and corporate sustainability reporting. By strategically utilizing market-based instruments and carefully structuring subsidies, it is possible to create incentives for adopting environmentally friendly practices while addressing market shortcomings.

The government's involvement in redistributive policies, the economic assessment of ecosystem services, and the implementation of participatory approaches in policy-making are all fundamental in fostering sustainable development and ensuring that the benefits of economic growth are equitably distributed among all segments of society.

DEFINITION AND HISTORICAL BACKGROUND

Sustainable growth involves achieving economic expansion while concurrently safeguarding and improving natural and social assets for future generations. It involves integrating the facets of economic, environmental, and social sustainability into development plans and strategies (Cafasso, 2019). This approach is based on the concept that sustainable long-term economic prosperity cannot be achieved if economic growth leads to environmental degradation or social inequality. Therefore, sustainable growth focuses on balancing these three dimensions to enhance overall human well-

being while preserving the health of natural ecosystems that are essential for economies and societies.

Sustainable growth encompasses various strategies and frameworks, including the sustainable growth strategy, which focuses on renewable energy sources, and the sustainable growth rate, which is the maximum rate at which a company can grow without overextending its financial resources. The sustainable growth model is a comprehensive theoretical framework that encompasses various elements of growth while incorporating principles of sustainability. This model takes into account economic, social, and environmental factors to ensure that growth is not only robust but also environmentally and socially responsible.

Through the implementation of sustainable economic strategies, firms and policymakers can establish a secure macroeconomic framework, guarantee entry into global markets, safeguard property rights, and allocate resources towards public goods that confer widespread societal advantages (Sadeh et al., 2021). This integrated approach is crucial for tackling current complex issues like climate change, dwindling resources, and socioeconomic disparities. It sets the groundwork for a future marked by collective prosperity and ecological robustness.

The concept of sustainable growth has undergone significant evolution over the years, influenced by a variety of economic theories and historical perspectives. One influential model in understanding sustainable growth is the stadial theory of development, which was extensively discussed during the Scottish Enlightenment by eminent thinkers such as Adam Smith. According to Adam Smith's stadial model, societies progress through successive stages characterized by additional modes of subsistence. These stages encompass the Age of Hunters, the Age of Shepherds, the Age of Agriculture, and the Age of Commerce. Smith proposed that each stage represents the prevailing mode of subsistence, serving as a marker of a society's advancement over time (Boulanger, 2008).

However, it is important to note that these stages of societal development may not necessarily follow a strict, linear progression. In fact, different modes of subsistence could coexist simultaneously. For example, when discussing the founding of Rome, Smith observed that it was established on agrarian law without acknowledging earlier stages such as hunting or shepherding. This suggests that the historical narrative may need to be completed or selective in its portrayal of societal modes of subsistence development.

The historical framework for understanding sustainable growth offers valuable insights into the dynamic and often non-linear nature of societal development. This framework emphasizes the importance of recognizing the diverse paths that societies can take, highlighting the need to adapt economic models to accommodate different stages and modes of subsistence. By doing so, it informs contemporary discussions on sustainable growth and underscores the complexity of achieving long-term economic and societal sustainability.

KEY PRINCIPLES

The foundational principles of sustainable growth embody a holistic framework aimed at harmonizing economic advancement with environmental conservation and social inclusivity. The following principles are essential for achieving sustainable growth.

Effective Governance

Effective governance is essential for the successful attainment of all Sustainable Development Goals (SDGs) and corresponding targets. While public sector reforms are crucial, they present a considerable challenge in numerous countries. The application of principles and associated strategies to public institutions can significantly accelerate endeavors to strengthen national and local governance capacities. This, in turn, will facilitate the realization of the 2030 Agenda and other international agreements.

The principles of effective governance are intended to assist nations in establishing accountable, inclusive, and effective institutions at every level. They aid in translating the institutional elements of SDG16 (Sustainable Development Goal 16) into actionable strategies, and they encourage the integration of effective governance into SDG implementation and development plans at all levels.

Environmental, Social, and Governance (ESG) Principles

The integration of Environmental, Social, and Governance (ESG) principles has become increasingly crucial for organizations striving for sustainable and ethical operations. Across the globe, companies are incorporating these principles into their fundamental strategies. This transformation is motivated by the growing expectations from consumers, investors, and regulators for heightened transparency and accountability. ESG Key Performance Indicators (KPIs) are essential metrics that provide quantifiable and tangible insights into a company's sustainability efforts and ethical impact on society and the environment.

These indicators serve as critical guides for companies as they navigate their journey towards fostering sustainable practices. Important KPIs encompass a wide range of aspects, including but not limited to waste management, which highlights a company's commitment to reducing and managing waste in an environmentally responsible manner. Moreover, biodiversity preservation is a significant KPI, reflecting a company's dedication to protecting and sustaining natural habitats and the diverse ecosystems they support. These KPIs collectively contribute to a comprehensive understanding of a company's environmental and social responsibility, thus enabling stakeholders to assess and support sustainable business practices.

A robust ESG framework has the potential to optimize investment returns by directing funds towards more viable and sustainable prospects while sidestepping investments that could be adversely affected by enduring environmental concerns. Additionally, ESG integration can significantly diminish expenses, such as mitigating escalating operational costs, ultimately bolstering financial outcomes.

Social Protection and Energy Sector Reforms

Social protection has become increasingly vital in assisting governments in addressing shocks and implementing energy sector reforms. Governments need to invest in well-structured social protection programs to effectively manage the tradeoffs between coverage, the generosity of cash transfers, and the fiscal savings from reform implementation. These investments play a critical role in supporting and enabling effective responses to economic and social challenges. In the short term, providing financial support to households through cash transfers can help alleviate potential negative impacts and make it easier to implement reforms. Looking ahead to the long term, it is

crucial to focus on enhancing the resilience of both households and the economy to withstand future shocks better. This resilience-building effort will ensure a fair and smooth transition to a lower carbon future (Banos & Azuela, 2023).

Integration and Accessibility of Science and Knowledge

The accessibility and seamless integration of scientific knowledge into the policymaking process are essential for making well-informed and effective decisions. This principle promotes and fosters collaborations that guarantee not only the availability of data but also its usability for a diverse range of stakeholders, including policymakers, researchers, and investors. Leveraging open-source technologies can significantly facilitate the widespread distribution of scientific insights, thereby empowering the more successful adoption of sustainable practices across various sectors and industries.

Sustainable Growth and Resource Allocation

Major changes, like those related to sustainability, involve redistributing resources within the organization, such as capital and operating expenses and talent. Small victories in the initial phases can create momentum for larger scale initiatives. Incorporating climate and sustainability programs into existing transformation endeavors can enhance business outcomes and sustainability achievements (Santamarta et al., 2022). To achieve sustainable growth, it is crucial to implement prudent financial strategies to prevent the repercussions of rapid expansion, which may require substantial changes such as issuing new equity or assuming additional debt.

To achieve sustainable growth, it is imperative to embed these principles into the strategies and operations of all stakeholders, regardless of their organizational level. This will facilitate the creation of a comprehensive and interconnected model that addresses the complex challenges of economic advancement, environmental conservation, and social equity. This approach helps achieve immediate objectives and ensures the well-being of future generations and the planet in the long run. Sustainable growth demands concrete actions across governance, business practices, and community engagement to bring about significant and lasting transformation.

ECONOMIC IMPLICATIONS

Several economic policies play a critical role in promoting sustainable growth. These encompass maintaining a stable macroeconomic environment, guaranteeing widespread access to the global economy, safeguarding property rights, and investing in public goods that benefit society. However, challenges arise when governments need to pay more attention to these issues, often due to a lack of understanding. Reinert (2020) underscores the pivotal roles of the state in establishing regulatory frameworks, managing income distribution, and fostering economic growth to advance societal well-being.

It is essential to have a strong and flexible policy framework that integrates economic valuation with policy and development options that give importance to preserving ecosystem services (ES). This framework is crucial in assessing the trade-offs among economic, social, and environmental goals. Effective policy tools include management and regulation, planning and regulation, and market-based mechanisms to improve access to natural resources and guarantee adequate environmental quality. This approach aims to consistently improve human well-being over time.

Participatory methodologies have a strong track record of enhancing resource allocation in local government budgeting. Quantitative evaluations show that involving citizens in decision-making contributes to improved financial results, fostering greater equity and practicality without sacrificing efficiency. However, further scrutiny is required to assess the impact of such involvement on policy implementation and its associated expenses. Stakeholder participation is widely acknowledged as crucial for identifying and addressing diverse needs and integrating ecosystem services into policymaking bolsters local strategies for effective ecosystem management (Gomez et al.,2023).

Addressing the "material footprint" is crucial for achieving sustainable growth, especially as it correlates with GDP growth. The expected increase in global material footprint as emerging economies grow could worsen environmental burdens without improvements in resource efficiency. The World Bank has reported significant disparities in access to basic services such as electricity and clean cooking solutions, underscoring the importance of implementing resource-efficient strategies to support sustainable growth (Sternfels et al., 2021).

Technological advancements, especially improvements in Total Factor Productivity (TFP), play a critical role in driving long-term sustainable economic growth. As capital investments experience diminishing returns, the need for technological progress becomes increasingly essential to maintain and boost GDP per capita growth. The concept of higher marginal productivity of capital and increasing savings rates in developing countries suggests that, in theory, there should be a convergence in per capita incomes between developed and developing nations over time. This convergence is anticipated as a result of the potential for developing nations to achieve higher rates of growth through technological catch-up.

The Green Growth Index evaluates a country's advancement toward sustainability goals, emphasizing the significance of efficient resource utilization, preservation of natural capital, the creation of green economic opportunities, and social inclusivity. Policies that support both incremental and transformative green technological innovations are crucial for transitioning to a sustainable economy. These policies should incorporate technology-driven, demand-oriented, and systematic approaches to facilitate sustainable technological advancements. Embracing green growth strategies can yield substantial economic, social, and environmental benefits, leading to significant short and long-term outcomes in terms of economic growth, environmental conservation, and poverty alleviation (Söderholm, 2020).

ENVIRONMENTAL IMPLICATIONS

In recent years, there has been a notable shift in the focus of environmental challenges, with greater attention being placed on addressing various diffuse emissions originating from sources such as road transport, shipping, aviation, and agriculture. Each of these sources, while not posing significant concerns individually, collectively contribute to substantial overall impacts on the environment. This combined effect has garnered increasing recognition due to its potential to lead to significant environmental consequences. The rising significance of global environmental challenges, which encompasses issues such as climate change, the impact of globalization, and the surge in international trade of consumer products, further compounds this problem. Tackling these challenges often necessitates international negotiations and equitable burden-sharing among nations. However, achieving consensus and implementing stringent global climate agreements has proven to be a complex and challenging endeavor, reflecting the intricacies of addressing these pressing environmental issues (Söderholm, 2020).

In the 1960s, environmental policies were centered on implementing stringent regulations on emissions into the air and water from stationary pollution sources, particularly industrial plants. These regulations, which were easier to monitor and enforce through plant-specific emission standards, aimed to reduce local environmental impacts, such as emissions into nearby river basins that affected local communities and industries.

Dealing with widespread emissions requires implementing indirect pollution control methods, such as encouraging recycling and efficient use of materials. However, these strategies face challenges such as product design and byproduct utilization, which can lead to unintended consequences like rebound effects. In addition, while promoting recycling and resource efficiency, it's important not to overlook the necessity of better tracking and tracing of hazardous substances and providing more incentives for environmentally friendly product design. Achieving this goal will require both technological advancements and changes in organizational practices.

Efforts to protect the environment are now focused on addressing climate change, minimizing air pollution, and conserving biodiversity. These efforts involve managing waste and wastewater, reducing pollution, protecting biodiversity and landscapes, and conducting research and development for environmental conservation. Expenditures for environmental protection encompass the financial resources and efforts dedicated to these activities, aimed at reducing and eliminating pollution and preventing environmental degradation.

Furthermore, climate change is expected to result in an increase in the frequency and unpredictability of weather events, with typhoons and hurricanes experiencing intensified precipitation and higher peak wind speeds due to the rising temperatures of tropical sea surfaces. The escalation of sea levels and storm surges presents substantial risks to low-lying areas, leading to heightened business continuity risks, elevated insurance costs, and diminished asset values, especially if international policy endeavors aimed at restricting warming to below two degrees celsius are required.

Immediate action is imperative to diminish the depletion of natural habitats and biodiversity, critical for global food and water security, climate change mitigation and adaptation, and overall peace and security. Forests, which sustain the livelihoods of approximately 1.6 billion people and harbor more than 80 percent of terrestrial species, play a pivotal role in this endeavor. Nature-based climate solutions have the potential to contribute around a third of CO₂ reductions by 2030. Ecosystems are estimated to hold a value of \$125 trillion per year for human livelihoods and well-being. The current climate commitments under The Paris Agreement only encompass one-third of the required emissions reductions to maintain the agreement's targets (United Nations, 2024).

SOCIAL IMPLICATIONS

Social protection is crucial for enabling governments to effectively respond to different types of shocks and supporting reforms, particularly in the energy sector. The experiences of various countries highlight the necessity of dedicating time and resources to creating programs that are suited to specific reform situations. These programs must carefully manage the trade-offs between the extent of cash transfer coverage and generosity and the fiscal savings resulting from the reform. Clear, effective, and targeted communication is also vital for driving forward these reforms.

In all advanced welfare states, similar challenges are encountered, but these challenges can appear differently within each welfare system. It is important to take into account the wider social support

framework, which includes not only government intervention but also the influence of markets and families. This comprehensive approach is essential for understanding the various issues that arise and for developing effective, all-encompassing solutions (Sadeh et al., 2021).

European nations are currently facing the challenge of modernizing their social protection systems, which demands close collaboration and concerted action at the European Union level to devise impactful strategies. The Sustainable Development Goals (SDGs) emphasize the crucial role of social protection in mitigating disparities and advancing environmental equity. Notably, SDG 10 sets a target to diminish inequalities by 2030 by establishing suitable social protection systems and initiatives that provide extensive coverage for disadvantaged and impoverished groups within society (Bhandari, 2024).

Furthermore, the pursuit of inclusive and high-quality education for all is fundamental to sustainable development. This objective involves guaranteeing that every girl and boy successfully finishes their primary and secondary education without any financial barriers, offering fair opportunities for affordable vocational training, and eradicating disparities in education based on gender and socioeconomic status. By the year 2030, the goal is to ensure that all young people, as well as a significant portion of adults, attain proficiency in literacy and numeracy, thereby equipping them with the knowledge and competencies necessary to advance sustainable development.

CONCLUSION AND DISCUSSION

Sustainable growth is a holistic approach that integrates economic, environmental, and social sustainability principles. It aims to ensure that the current development meets the needs of the present without compromising the ability of future generations to meet their own needs. At its core, sustainable growth relies on effective governance, the incorporation of Environmental, Social, and Governance (ESG) principles, the implementation of social protection measures, and the allocation of resources in a considerate and responsible manner. The primary goal is to enhance human well-being and quality of life while concurrently preserving natural ecosystems and biodiversity.

This approach fosters cooperation among various stakeholders including governments, businesses, communities, and individuals. By leveraging innovative and sustainable practices, the aim is to address pressing global challenges such as climate change, resource depletion, and social inequality. Through the adoption of sustainable growth principles, it is possible to collectively work towards a more sustainable and equitable future for all.

The key principles for transforming economies towards sustainable practices include effective governance, the integration of Environmental, Social, and Governance (ESG) criteria, and the implementation of social protection programs. Effective governance is crucial as it ensures accountability and inclusivity, allowing all stakeholders—governments, businesses, and communities—to work together in pursuing sustainable development goals (SDGs).

In addition to governance, the significance of resource allocation and market-based instruments cannot be overstated. It is essential to reallocate resources within organizations to align with sustainability initiatives. This transformative process not only enhances business performance but also supports the resilience of ecosystems and societies in addressing complex issues such as climate change and social inequality. The reallocation of resources reflects a commitment to sustainability and can have a positive impact on both business operations and the broader environment.

Overall, sustainable growth presents a pathway for future-oriented development, driving not only economic resilience but also fostering a healthier planet and society. As various stakeholders collaborate, empower communities, and integrate sustainability into core strategies, the vision of a prosperous, equitable, and environmentally sustainable world can transition from aspiration to reality. Thus, the journey toward sustainable growth reflects not just a theoretical framework but a call to action that necessitates the participation and commitment of all sectors of society.

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**METABOLOMIC MODELLING AND NEUROPROTECTIVE EFFECTS OF
CARVACROL AGAINST ACRYLAMIDE TOXICITY IN RAT'S BRAIN AND SCIATIC
NERVE**

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Abstract

Introduction and Purpose: The aim of this study was to investigate the harmful effects of acrylamide (AA), which is formed in carbohydrate-rich foods at temperatures above 120°C, on the central and peripheral nervous systems and to evaluate the potential neuroprotective effects of carvacrol (CRV), a natural compound found in plants, especially oregano oil, known for its antioxidant, anti-inflammatory and neuroprotective properties.

Materials and Methods: Male Wistar Albino rats were exposed to acrylamide (AA) at a daily dose of 40 mg/kg body weight and carvacrol (CRV) at a dose of 50 mg/kg body weight for 15 days. In the assessments performed after the last administration, gait abnormalities, increased thermal sensitivity, and altered paw withdrawal thresholds were observed in AA-exposed rats.

Results: AA decreased glutathione (GSH) levels and increased malondialdehyde (MDA) levels in both brain and sciatic nerve tissues. In addition, AA decreased NR4A2 expression and increased nuclear factor erythroid 2-related factor 2 (Nrf2), caspase 3, and nuclear factor κ B (NF- κ B) gene expressions. Concomitantly administered CRV alleviated gait abnormalities, increased GSH levels, and decreased MDA levels in both tissues. CRV also regulated gene expression, decreasing Nrf2 and NF- κ B, while increasing NR4A2.

Discussion and Conclusion: Histopathological signs of AA-induced neurodegeneration and high levels of glial fibrillary acidic protein observed in brain and sciatic nerve tissues were corrected with simultaneous application of CRV, providing neuroprotective effects in both regions. This study effectively addresses the existing limitations in the literature and plays a pioneering role in revealing the neuroprotective potential of CRV against AA-induced neurotoxicity in both the central and peripheral nervous systems. Consequently, the study demonstrated AA-induced neurodegeneration in the brain and sciatic nerves and showed that CRV significantly reduced this neurotoxicity. This new research highlights the potential of CRV as a neuroprotective agent against AA-induced adverse effects in both the central and peripheral nervous systems

Key Words: Acrylamide, Carvacrol, Neuroprotective effect, Antioxidant.

**INVESTIGATION OF THE MECHANICAL BEHAVIOR OF AISI 316L AUSTENITIC
STAINLESS STEEL AFTER THE JOINING OF AISI 316L AUSTENITIC STAINLESS
STEEL USING TIG WELDING METHOD AT 120 AMPER CURRENT INTENSITY**
**AISI 316L ÖSTENİTİK PASLANMAZ ÇELİKLERİN TIG KAYNAK YÖNTEMİ İLE 120
AMPER AKIM ŞİDDETİNDE BİRLEŞTİRİLMESİNDEN SONRA GERÇEKLEŞEN
MEKANİK DAVRANIŞLARININ İNCELENMESİ**

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ABSTRACT

Introduction and Purpose: In this study, the use of stainless steels in today's rapidly developing and advancing manufacturing sector and the material selection according to these usage areas are discussed. The mechanical behavior and microstructures of AISI 316L stainless steels were examined by joining the samples with TIG welding at a current intensity of 120 amperes.

Materials and Methods: Fimer TT205 Inverter AC-DC brand TIG welding machine was used to combine the samples. Tensile and three-point bending experiments were carried out with an MTS 370.10 brand device with a force capacity of 100 kN. Microhardness measurement was carried out using the HWMMT-X3 test device and the Vickers hardness measurement method. Microstructural analyzes were carried out with an OLYMPUS brand optical microscope.

Results: As a result of the tensile tests, the average yield strength of repeated tests was evaluated as 276.1 MPa, tensile strength as 463.4 MPa and the average percentage elongation as 34.4%. During the three-point bending test process, the prepared samples were bent up to 180°. No crack formation was observed in the welded area after bending. After micro hardness measurements, it was observed that the values in hardness measurements increased as we moved from the main material to the welding area. As a result of microstructural analysis, it was determined that the materials grew at

the grain boundaries with the heat ferritic structure resulting from the flux occurring in the weld and HAZ.

Discussion and Conclusion: In this study, the microstructure and mechanical behavior of the material after welding were examined and compared with theoretical data according to the main material. The microstructure has changed depending on the welded area in the main material because it is under the influence of heat. While the tensile and strain values decreased due to being under the influence of heat, the yield strength increased. No change was observed in the bending and forming properties, and the hardness values taken from various points on the sample increased as it moved from the main material towards the HAZ and welding area. According to literature research, the data obtained are compatible.

Keywords: AISI 316L; 120 Amperes; TIG welding; Mechanical behaviors; Microstructure analysis

ÖZET

Giriş ve Amaç: Bu çalışmada günümüzün hızla gelişen ve gün geçtikçe ilerleyen imalat sektöründe paslanmaz çeliklerin kullanımı ve bu kullanım alanlarına göre malzeme seçimlerine değinilmiştir. TIG kaynağı ile numuneler 120 amper akım şiddetinde birleştirilerek AISI 316L paslanmaz çeliklerin mekanik davranışları ve mikroyapıları incelenmiştir. **Gereç ve Yöntem:** Numunelerin birleştirilmesinde Fimer TT205 İnverter AC-DC marka TIG kaynak makinesi kullanılmıştır. Çekme ve üç nokta eğme deneyleri MTS 370.10 marka 100 kN kuvvet kapasiteli cihaz ile gerçekleştirilmiştir. Mikrosertlik ölçümü HWMMT-X3 test cihazı ile vickers sertlik ölçüm yöntemi ile gerçekleştirilmiştir. Mikroyapı analizleri OLYMPUS marka optik mikroskobu ile gerçekleştirilmiştir. **Bulgular:** Çekme testleri sonucunda tekrarlanan testlerin ortalama akma dayanımı 276,1 MPa, çekme dayanımı 463,4 MPa ve ortalama yüzde uzama miktarı %34,4 olarak değerlendirilmiştir. Üç nokta eğme testi işlemi süreci esnasında hazırlanmış numuneler 180°'ye kadar eğilmiştir. Kaynaklı bölgede eğilme sonrasında çatlak oluşumları gözlenmemiştir. Mikro sertlik ölçümleri sonrası anamalzemeden kaynak bölgeesine doğru ilerledikçe sertlik ölçümlerindeki değerleri yükseldiği görülmüştür. Mikroyapı analizleri sonucunda malzemelerin kaynak ve ITAB'da oluşan akından kaynaklı ısı ferritik yapı ile tane sınırlarında büyüme gerçekleştirdiği tespit edilmiştir. **Tartışma ve Sonuç:** Bu çalışmada, malzemede kaynak sonrası mikroyapı ve mekanik davranışlarının incelenmesi anamalzemeye göre teorik verilerle kıyaslanmıştır. Mikroyapı ana malzemede kaynaklı bölgeye göre ısı tesiri altında olduğu için değişimler göstermiştir. Çekme ve gerinim değerleri de ısı tesiri altında kaldığından dolayı azalır iken akma dayanımı artış göstermiştir. Eğilme ve şekillendirilebilme özelliklerinde herhangi bir değişiklik gözlenmemiş olup numune üzerinden çeşitli noktalardan alınan sertlik değerleri anamalzemeden ITAB ve kaynak bölgesine doğru ilerledikçe artmıştır. Literatür araştırmalarına göre elde edilen veriler uyumluluk göstermektedir.

Anahtar Kelimeler: AISI 316L; 120 Amper; TIG kaynağı; Mekanik davranışlar; Mikroyapı analizi

INTRODUCTION AND PURPOSE

The world is developing rapidly and the industry is growing rapidly. The biggest obstacle to this rapid growth and development is the corrosion problem and material strength of the materials used in the industry. Since austenitic stainless steels have the best corrosion resistance and material strength against all environmental conditions, their areas of use are expanding and increasing

rapidly. As a result of the welding methods used during the joining of metals used in today's industry and the changes in the molecular structure of the materials, starting from the welding areas, various corrosion resistances and strength decreases occur.

In order to understand and examine the changes in the mechanical and chemical properties of the material with TIG welding at 120 ampere current applied to AISI 316L austenitic stainless steel, which is the subject of this study, it will enable us to understand the mechanical effect of the chemical composition distribution formed in the ITAP region of the tensile, hardness and welding on the microstructure of the material. ITAB is the region surrounding the weld metal and directly affected by the heat released during the welding process and the cooling that occurs after the welding process. Therefore, the microstructure of the sample also changes according to the applied current value (Topcu, 2019).

While doing these studies, it is necessary to know the parameters such as the chemical composition of the material in the welding area of two 316L plates, the chemical composition of the filler material used for welding, the welding method used and the heat input. The reason for all these experiments, researches and scientific studies is that AISI 316L austenitic stainless steel finds its usage area in many areas in our region and in the world due to its distinctive characteristics such as corrosion resistance and long material life.

MATERIALS AND METHODS

Welding Method

In this study, the samples prepared within the scope of experimental studies were 316L austenitic stainless steels due to their superior properties and weldability. Table 1 shows the chemical compositions of these types of stainless steels.

Table 1 Chemical composition of austenitic stainless steel AISI 316L

E	GRAD	C	M	P	S	S	C	N	M
	316L	0.0	2	0.04	0.0	1	1	1	2-
		3	5	3		6-18	0-14	3	

Welding of all samples was carried out using argon gas with the TIG welding method. It was preferred to use Fimer TT205 Inverter AC-DC brand TIG welding machine.

Table 2 Features of the TIG welding machine Fimer TT205

Item:	TT 205 Inverter AC/DC
Brand:	Fimer
Maximum Power – MMA:	3,8 KWA 16 A
Maximum Power – Tig DC:	3,2 KWA 16 A
Maximum Power – Tig AC:	3,2 KWA 16 A
Input Voltage:	230 V
Idle Operating Voltage:	85 V
Current Range -MMA:	5 - 170 A
Current Range -Tig DC:	5 – 200 A
Current Range -Tig AC:	5 – 200 A
Operating Efficiency -MMA:	%35–170 A / %60-135 A / %100- 110 A
Operating Efficiency -Tig DC:	%35-200 A / %60-180 A / %100- 155 A
Operating Efficiency -Tig AC:	%35-200 A / %60-175 A / %100- 145 A
Weight:	16 Kg
Dimensions:	270 * 600 * 450 mm
Electrode Diameter:	1,5 - 4 mm

Table 2 shows the features of the welding machine used in the experimental studies.

Tungsten electrode will be selected and used as red and 2mm in diameter (Figure 1). Tungsten electrode is the material that conducts current and creates the arc during welding in the TIG welding method. It can be produced in different types and is specified as a standard in international AWS and ISO standards.



Figure 1 TIG welding tungsten electrode

For the welding process of sample stainless steels in the experimental studies, the 2 mm diameter ER316L TIG austenitic welding wire used in the joining method of corrosion resistant steels with tig welding was preferred. Thanks to its low carbon content, it is resistant to scaling up to 800°C and allows operation up to 400°C. It is generally produced for use in sectors such as shipping, chemistry, food, paint, textile, tanks and kitchenware. Table 3 shows the chemical components of the welding wire used.

Table 3 Chemical composition of ER316L welding wire used in the experimental study

Grade	C	Mn	P	S	Si	Cr	Ni	Mo	Cu
Er 316L	≤ 0.03	1-2.5	≤ 0.03	≤ 0.03	0.3-0.65	8-20	1-14	2-3	≤ 0.75

Table 4 Mechanical properties of ER316L TIG welding wire

Mechanical Properties	Tensile Strength (MPa)			Elongation at Break A (%)			
	≥ 490			≥ 30			
Thickness Ø(mm)	0.8	1	1.2	1.6	2	2.5	3.2
Current (A)	70~150	100~200	140~220	50~100	100~200	200~300	300~400

Table 5 shows the welding parameters and welding types to be used for the study.

Welding Method	Welding Type	1. Electrode 2. Material	Current (A)	Voltage (V)	Wire Speed (mm/s)	Welding Thickness(mm)
TIG	X welding method front welding	316 L	120	12.4	2.95	5
Welding Machine Brand / Model			Fimer / TT 205 Inverter AC/DC			
Standard Electrode Type / Diameter			Red Tungsten / 2 mm			
Additional Welding Wire / Diameter			ER316L / 2 mm			
Nozzle Diameter			7.9 mm			
Protective Gas			Argon			
Welding Substrate			316L Sheet Metal			
Ambient Conditions			Room temperature			

Tensile Test

The samples joined with font welding will be prepared in accordance with TS EN ISO 4136 standard and the tensile test will be performed and the tensile strength and elongation of the samples until the breaking point will be measured by placing them in the test device. The tensile test was applied to 3 samples joined with TIG welding at 120 ampere current at room temperature until breaking by applying continuous tension on the sample with certain load intervals. The average of the measured values of 3 prepared samples was taken in order to minimize the errors that may occur during the test.

The tensile testing machine used for the study is MTS 370 with a force capacity of 120 kN (Figure 2).

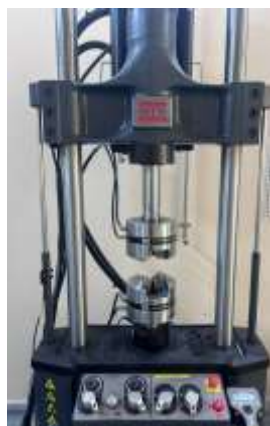


Figure 2 Tensile Testing Machine MTS 100kN

Figure 3 shows the sample drawing prepared for tensile testing of welded metal materials according to TS EN ISO 4136 standard.

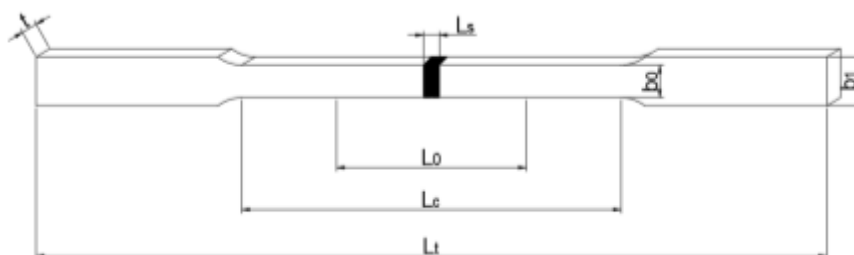


Figure 3 Sample dimensions for tensile testing.

Table 6 shows the mechanical properties of 316L stainless steel at room temperature.

Table 6 Mechanical properties of AISI 316L at room temperature.

Mechanical Properties at Room Temperature	
Material	316L
Breaking Strength	485 MPa
Yield Strength (%0.2)	170 MPa

3 Point Bending Test

In this study, 3-point bending test was carried out with 2 lower rolls with a diameter of 40 mm and an upper pressure roll with a diameter of 50 mm. The distance between supports is 70 mm. Deformation and bending speeds were observed by bending at a feed rate of 180° and 5 mm/min. The test device is MTS 370, 100 kN capacity (Figure 4).

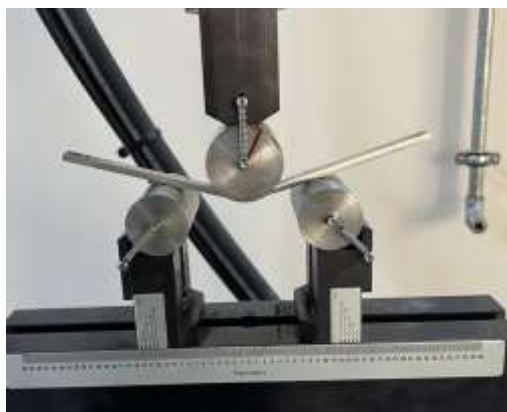


Figure 4 Three point bending test

Samples prepared according to ISO 5173 standard were prepared by cutting 2 samples on a fiber laser cutting machine in order to reduce the errors that may occur during the test (Figure 5). The average of the measured values of each 2 separate welding parameters was taken.



Figure 5 Three point bending test specimen

Microhardness Measurement Method

In this study, hardness values were measured with 3 pieces of 200 gf load at certain intervals from the base material (BM), HAZ and weld zone (WZ) with the Vickers hardness measurement method using the HWMMT-X3 test device. The surface of the sample was sanded by applying 180, 320, 600, 800, 1000 and 1200 grit sandpaper, respectively, and the surface roughness was removed and the welded materials were polished, then etched with pure water and HCL solution.

The image of the test device is shown in Figure 6.



Figure 6 HWMMT-X3 Vickers hardness measuring device

Microstructure Studies

In this study, the parts cut from the sample welded in the ampere welding parameter were polished after being sanded with 180, 320, 600, 800, 1000 and 1200 grit sandpaper in order to be observed in the OLYMPUS CX21 optical microscope. The polished materials obtained were etched by electrolysis for 15 seconds under 1.2 ampere 3.8 volts in a solution prepared with 40 ml of pure water and 120 ml of HCL.

Image acquisition studies were carried out with the OLYMPUS CX21 optical microscope shown in Figure 7.



Figure 7 OLYMPUS CX21 optical microscope

RESULTS

Tensile Test Results

Table 7 shows the yield and tensile strengths and percent strain values of 3 samples joined with TIG welding at 120 ampere current. Average values were calculated as a result of the tensile test. Yield strength was evaluated as 276.1 MPa, tensile strength as 463.4 MPa and average percent elongation as 34.4%.

Table 7. Tensile test results of samples welded with 120 amps.

Sample	Yield Stress (N/mm ²)	Tensile Stress (N/mm ²)	Elongation (Strain) (%)
120 A-1	263.44	449.8	36.3
120 A-2	283.27	472.6	33.3
120 A-3	281.63	467.8	33.6
AVERAGE	276.1	463.4	34.4

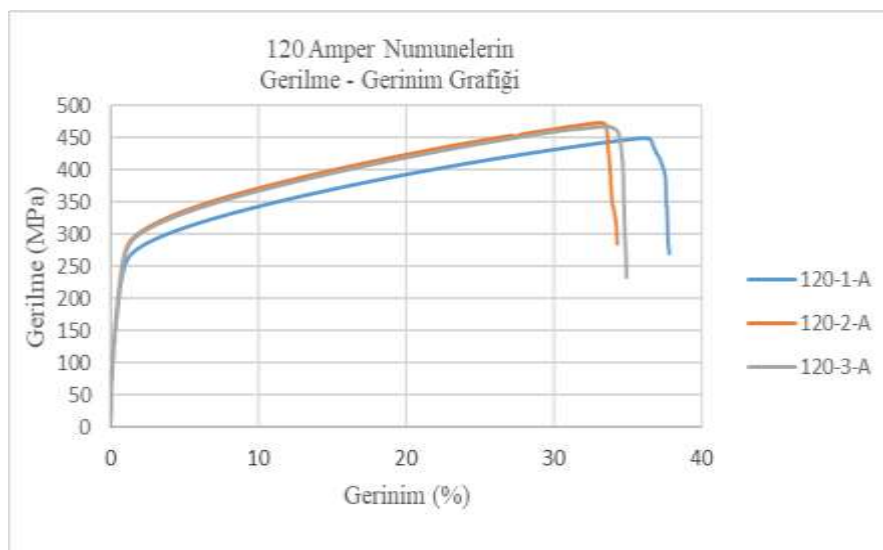


Figure 8 Stress-strain (%) graph of samples welded with 120 amps.

Figure 8 shows the graph of stress and percent strain values in MPa of 3 samples welded with 120 amps using TIG welding.

Table 8 Average value tensile test results of 120 ampere samples

Sample	Yield Stress (N/mm ²)	Tensile Stress (N/mm ²)	Elongation (Strain) (%)
Base Material 316L	170	485	40
ER 316L Additional Welding Wire	400	490	30
100 A. Average 316L/316L	276.1	463.4	34.4

Table 8 shows the standard yield, tensile strength and percentage elongation values for the main material additional welding wire and the average values of the tensile test samples welded at 120 ampere current.

The ruptures occurred outside the HAZ, after the weld affected area.

Three Point Bending Test Results

In this study, three-point bending test was used to examine the formability behaviors of test samples obtained from welded plates at 120 ampere current parameter. During the test process, 2 samples were bent up to 180°. No crack formations were observed in the welded area after bending (Figure 9). It was observed that there was no change in the formability feature. AISI 316L austenitic stainless steels have good formability behaviors due to their structures.



Figure 9 Deformation examination of the samples as a result of three-point bending test.

Table 9 Three-point bending test results of samples welded with 100 amperes

Sample	Maximum Stress (N/mm ²)	Bending Stress (N/mm ²)	Bending (mm)	Visual Inspection
120-1	841	171	85	No deformation
120-2	825	173	85	No deformation
AVERAGE	833	172	85	

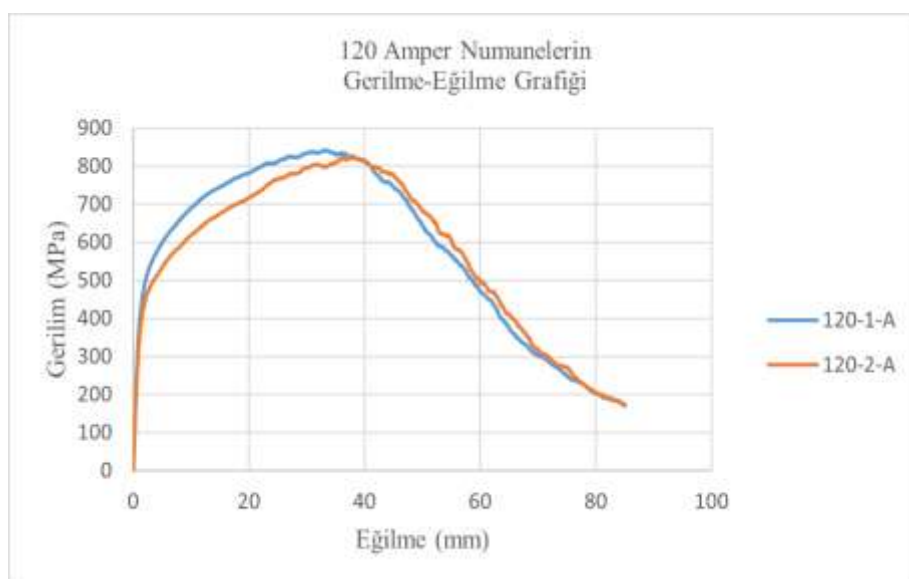


Figure 10 Three point bending test graph of samples welded with 100 amps

Mikrosertlik Ölçüm Sonuçları

In all samples joined with different welding current parameters, the hardness value is formed in the welding region, followed by the HAZ and the main material. In Table 4.7, the data of the microhardness graph is given in a tabular form.

Table 10 Microhardness test results of samples welded with 120 amps

		Micro Hardness Values (HV)
	Number	120 Ampere
Base Material AISI 316L (BM)	1	140
	2	155
	3	178
HAZ	4	190
	5	195
	6	200
Welding Zone (WZ)	7	210
	8	215
	9	220

Microstructure Studies

The microstructure of the sample combined with an optical microscope at a current parameter of 120 ampere was imaged, and the main material (BM), weld transition zone (ITAB) and weld zones (WZ) were displayed (Figure 11).

During the joining process with TIG welding method, due to the increase in heat input at 120 ampere current value, grain structure growth occurred in weld metal and HAZ. The growth of grain structures is due to the heat generated in the weld region and the increase in cooling time of the weld region. Since the cooling rate decreases, the time to solidify in the weld region will also increase, and growth occurs in grain structures.

HAZ is the region surrounding the weld metal and is directly affected by the heat released during the welding process and the cooling that occurs after the welding process. Therefore, the microstructure of the sample also changes according to the applied current value (Topcu, 2019).

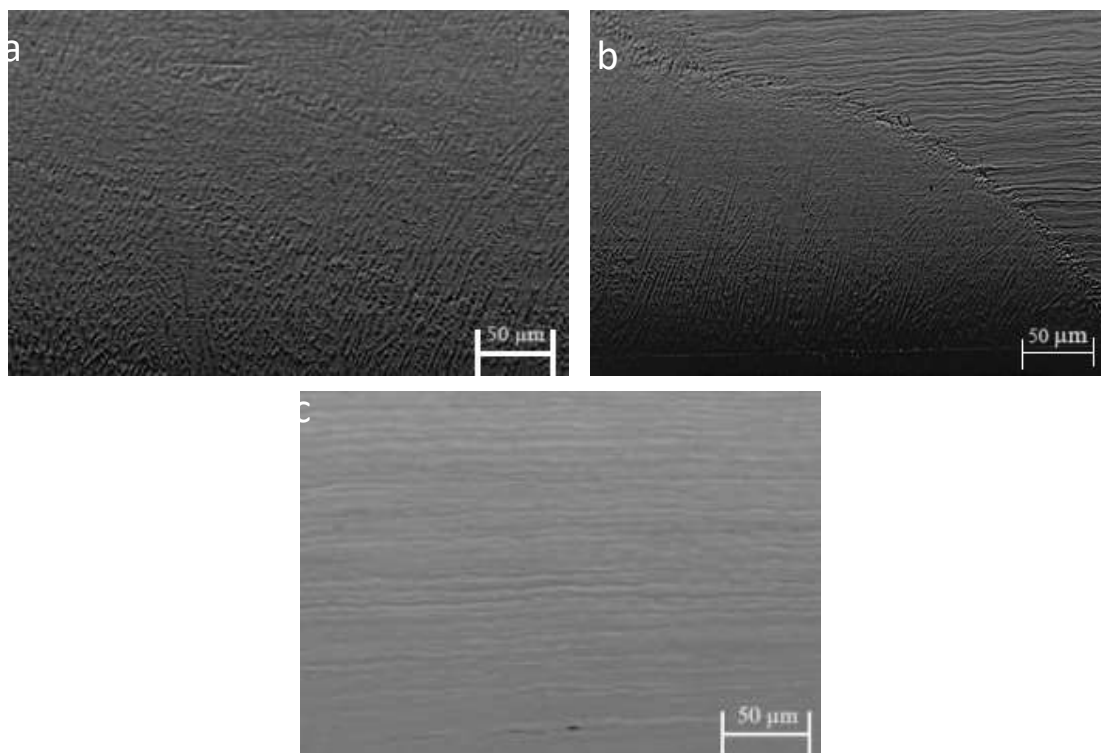


Figure 11 Optical microscope image of the microstructure sample prepared with 100 ampere current source parameter; (a) Weld metal (WZ), (b) Weld transition zone (HAZ), (c) Base material (BM).

DISCUSSION AND CONCLUSION

AISI 316L austenitic stainless steel plates, which have a wide range of uses such as shipping, medicine, construction and automotive sectors, were seamlessly joined by using a \varnothing 2 mm tungsten electrode, \varnothing 2 mm ER316L welding wire and a 120 ampere current parameter under protective argon gas at room temperature with the TIG welding method, provided that all conditions remain constant. Tensile test, three-point bending test, microhardness analysis and microstructure examination samples were prepared from the joined plates. Tests and analyzes were carried out with these prepared samples and the obtained data were examined for the effect of the joining process, which was carried out at a current parameter of 120 ampere, on the mechanical behavior and microstructure of the material.

The average values of the test results of the sample combined with the TIG source prepared for the tensile test at 120 ampere current parameter were taken. The average yield strength of the samples is calculated as 276.1 MPa. The yield strength was measured more than the standard yield value of the main material in the sample at 120 ampere current parameter. The average tensile strength in the 120 ampere current samples was calculated as 463.4 MPa. The tensile strength is slightly less than the main material in the sample combined at 120 ampere current parameter. The average percent strain was measured as 34.4. In tensile test, fractures and ruptures in materials occur in materials with brittle fracture characteristics (Zhou and friends, 2018). The measurements obtained after the tensile test are consistent with the literature (Topcu, 2019). The rupture in the samples occurred in the region where the heat was exposed immediately after the HAZ and cooling occurred rapidly.

As a result of the three-point bending test, the samples joined with the TIG welding method and a current parameter of 120 amps have the ability to be shaped without any problems under normal conditions. AISI 316L austenitic stainless steels are materials with good shapeability due to their structure.

Microhardness studies are carried out to measure the hardness of the weld zone and HAZ of the sample prepared from AISI316L plates joined together with TIG welding method at 120 ampere current parameter. In microhardness studies, the highest hardness in the weld zone (WZ) was measured as 220 HV, and the highest hardness in HAZ was measured as 200 HV. It was observed that the measured hardness values decreased from the weld zone to the main material. The studies are in accordance with the literature studies (Erođlu and Aksoy, 1999).

In TIG welding, the temperature increases in the region where the weld is made and there are differences in the cooling rate (Topcu, 2019). Since the changes in the cooling rate directly affect the solidification rate in the weld pool, the grain structure of the sample increases and a decrease in hardness is observed in the heat-affected regions (ITAB) and the welding region (WZ) (Kılınçer and Kahraman, 2009)

After the microstructure examinations with optical microscope, it is observed that in all samples, as the main material progresses to the weld region, the grain structures grow because the carbon atoms in the weld region move from the grain boundaries to the inner part of the grain structure of the material due to the heat released due to welding (Anık, 1991). As a result of the observations made, no defects due to welding are observed in the root and weld regions, and no inconsistency is observed between the experimental study and the literature studies.

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